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55TH CONGRESS, 3d Session. | HOUSE OF REPRESENTATIVES. | DOCUMENT No. 267.

PROGRESS

OF THE

BEET-SUGAR INDUSTRY

IN THE

UNITED STATES

IN

1898.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1899.

CONCURRENT RESOLUTION.

Resolved by the House of Representatives (the Senate concurring), That there be printed fifty thousand additional copies of the Special Report on the Beet-Sugar Industry in the United States, submitted to the House of Representatives in a message of the President of the United States of date March first, eighteen hundred and ninety-nine; twenty thousand for the use of the House of Representatives, ten thousand for the use of the Senate, and twenty thousand for the use of the Department of Agriculture.

MESSAGE.

To the Senate and House of Representatives:

I transmit herewith for the information of Congress a communication from the Secretary of Agriculture, covering a report on the progress of the beet-sugar industry in the United States during the year 1898. It embraces the results of numerous chemical analyses and the observations made by a special agent in various parts of the United States.

WILLIAM McKINLEY.

EXECUTIVE MANSION,
March 1, 1899.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of the Secretary,
Washington, D. C., March 1, 1899.

Mr. President: I have the honor to transmit for your information and that of the Congress of the United States a report on the progress of the beet-sugar industry in this country in 1898. This report is divided into two parts.

The first part gives a general survey of the field of practical operations both in the production of beets and in the manufacture of sugar. This portion of the report was prepared by Mr. Charles F. Saylor, special agent of the Department of Agriculture.

The operations of all completed factories are summarized, their successes and failures are noted, and their experiences in dealing with obstacles are recounted. A survey of prospective developments is also included, in which are noted the efforts being made to establish factories at various points and the prospects of success.

Special attention is called to the interest of farmers, cattle feeders, and dairymen in the use of pulp as a food for animals. Farmers are also strongly advised to try the experiment of raising sugar beets for stock-feeding purposes.

In a chapter devoted to Porto Rico is shown the probable effect of competition between the producers of beet sugar in this country and the producers of cane sugar in that island.

The second part, prepared by Dr. H. W. Wiley, chemist of the Department of Agriculture, presents the chemical data secured by the analyses in the Division of Chemistry of sugar beets received from the various parts of this country.

The seeds from which the beets were grown were distributed by the Department of Agriculture in the spring of 1898. Each person receiving seeds was supplied with printed instructions for planting the seeds, cultivating the beets and harvesting them, and for sending samples for analysis.

The chemical data are supplemented by a brief discussion taken from the reports received from each State. These data show that the previous investigations made under the supervision of the chemist respecting the areas most suitable for the culture of beets are fully corroborated. The investigations have now proceeded far enough to enable us to determine with some degree of accuracy the localities where sugar-beet culture is destined to be most successful. It is seen that the Pacific coast still holds the leading place in furnishing areas of this kind. Almost equally favorable areas are presented by Michigan, New York, and a few other States in the northern and eastern portions of the country.

In the arid regions the areas suitable for beet culture have been partially mapped out, without reference, however, to the availability of water for irrigation purposes. It has been demonstrated that where irrigation can be carried on there are large areas in the arid regions where beets of superior excellence can be produced. Investigations have further shown that the limits of successful beet culture can only in exceptional instances be pushed south of the isotherm representing a mean temperature of 71° for the months of June, July, and August.

Further investigations which could profitably be conducted by the Division of Chemistry in this direction would be a detailed mapping out of the beet areas, with reference to the physiography, cheapness of fuel, rainfall, and markets.

The investigations brought out in the former report in regard to the utility of the by-products of the sugar-beet industry as cattle food should not be lost sight of. It is evident that the sugar industry and the dairy industry can best flourish side by side.

In view of the importance of the subject, I have the honor to recommend that at least 20,000 copies be printed for the use of the Department in addition to the number which Congress may in its wisdom order for the use of the members thereof.

I have the honor to remain, Mr. President,

Very respectfully,

JAMES WILSON, *Secretary*.

The PRESIDENT,
Executive Mansion.

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PROGRESS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES IN 1898.

REPORT OF SPECIAL AGENT

CHARLES F. SAYLOR.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SPECIAL AGENT,
Washington, D. C., February 28, 1899.

SIR: I submit herewith for your inspection and approval my report for 1898 as special agent and investigator of the production of domestic sugar from beets, sorghum, and cane, which is submitted in compliance with your instructions of April 10, 1897.

CHARLES F. SAYLOR, *Special Agent.*

Hon. JAMES WILSON,
Secretary of Agriculture.

INCREASE IN THE USE OF SUGAR.

A study of the increase in the utilization of sugar is very interesting. It is apparent to those who are making a careful study of statistics with reference to the commercial growth of commodities and an analytical investigation of their various uses, direct and indirect, that the increase in the use of sugar in our country by far exceeds the increase in population. The average gain in consumption for the last twenty-three years has been about 12 per cent per annum, or a doubling of consumption in less than ten years. While the exact rate of increase of our population can not be given, it can hardly be estimated at above 3 per cent annually.

The object of this report is to offer encouragement and information regarding the rise and development of the beet-sugar industry in this country. Since there is no market in the world equal to our own, and we are supplying a very small proportion of that, we should carefully study our home demand in order to get an intelligent idea of the future consumption of sugar in this country. In the first place, we must take into account the demand for this article for daily use as a part of our food ration. There is hardly one of the 75,000,000 inhabitants in this country that does not use sugar to some extent as a part of his daily food. It is both a luxury and a necessity, and as our people are becoming gradually better fixed financially, there is an increasing tendency toward luxury. This presages a greater increase in its use as we progress. When we turn to the use of sugar in an indirect way, a field of possible and probable extension opens up before us such as I apprehend does not occur with any other commodity. Take for instance the increased use of sugar incident to the manufacture of different kinds of sirups and tinctures, the making of confectionery, and the preserving of fruits of all kinds. There would appear to be no limit in this direction to the increase in the use of sugar. In addition to the increase of the new preparations of this kind, we have the increase in exports to other countries of commodities in the preparation of which sugar is used. Here is a factor that enters into this question of increase that is absolutely beyond computation. A study of our foreign commerce reveals the fact that it is and has been growing fast. We have vast resources for producing and preserving all kinds of fruits in this country; in fact, there can be only one limit to the production of sugar-preserved fruits, that is, our ability to dispose of the product. Our nation is in a transitional period. From producers of crude and raw material we are coming to be producers of finished products. We are growing into a great commercial nation. The best thought of students of agriculture, as well as the best ability of statesmen, is being directed to a study of our commerce and trade relations with the result that we are very quickly extending our trade, and with indications that it will reach vastly greater proportions.

I have been very much interested in the investigations that have been going on in this country and in Europe, especially in Germany, with reference to the value of sugar as a muscular-strength giver. A great many experiments have been made and all appear to show that sugar administered to workmen, soldiers, and others of whom great muscular endurance is required, greatly enhances their powers of endurance. Serious consideration is being given the subject by those in power with reference to its introduction into the German army for this purpose. Robert Hennig, writing from Berlin to the Louisiana Planter and Sugar Manufacturer, says:

> The experiments with respect to the addition of sugar to the soldiers' fare are to be continued this year on a large scale. A whole army corps will get sugar during the next maneuvers, and it is expected that in case these experiments have also good results, then the general introduction of sugar into the bill of fare of our military will be decided upon.

Some scientists go so far as to claim that all foods taken into the body, such as starches, fats, and albumens, are transformed into sugar before the process of assimilation in the body takes place or is possible. Indeed, it is a well-known established law of physiology that the first act of digestion takes place in the mouth by the transformation of starches into grape sugar. While the facts may not justify all that is claimed by the aforesaid scientists, yet it is well established by experience that sugar as a food has a vitalizing and restoring power. This fact once established for it, through the extensive experiments now going on, one can readily see that on account of its cheapness, palatability, and digestibility it will become at once an important factor in the army ration and in the ration of the tin-bucket brigade and all others whose activities of life need this strength-giving power. Here would open a field for an increase in the demand of this commodity that can be measured by imaginative conjecture only.

SUGAR PRODUCTION DURING 1898.

CALIFORNIA.

The past year must be considered a very unfortunate and unfavorable year for the production of beet sugar in that section of our country where the greatest amount is produced, namely, the Pacific coast. This was occasioned by the severe drought that prevailed in that section during the time when they should have received their supply of moisture. The precipitation upon which the growers depend for making their crops of beets falls largely in the winter; in fact, the fall of rain during the growing season of the sugar beets is very small. The conditions there are such that, if sufficient supply of moisture falls during the winter, it will readily carry the crops through the germinating and growing season. The winter rains preceding the crop year of 1898 were insufficient, the resulting drought being one of the most serious that has afflicted that country. Especially is this true of the southern part of the State of California. The Alvarado, Crockett, and Watsonville factories ran on a limited supply of beets, about one-half to three-quarters of what they had anticipated, while the factory at Los Alamitos had a campaign of only seven to ten days. The campaign at Chino was curtailed more than that of the factories in the northern part of the State. The factories at Salinas and Oxnard, after it was discovered that the supply of beets would be quite limited, were not put in order for the year's work, the beets at Salinas being shipped to Watsonville and those at Oxnard to Chino.

The Crockett factory, conducted by the California Beet Sugar Refining Company, Crockett, Cal., with daily capacity of 500 tons, had a fairly good start, but like the other factories in the northern part of the State having only a partial supply, its capacity was only partially shown, its campaign lasting only about thirty days. This factory proposes to place pulp on board the cars or wagons and charge $1 a ton for the same. Its capacity is about 500 tons per day. This factory is also a refinery and refines raw sugar from the Hawaiian Islands. It offers to contract at a price of $4.50 per ton for beets.

The Alvarado factory has a capacity of 800 tons. The endeavor of this factory was to raise about 85,000 tons of beets for the campaign of 1898, but they actually secured only about half that amount. This is the oldest factory in the United States. They have been making beet sugar at Alvarado for thirty years.

The Watsonville factory has a capacity of 1,100 tons. It makes raw sugar and ships to the refinery. The value of pulp is appreciated more by the farmers, feeders, and creamery men, and it brings a higher price than at any other factory in this country. The factory worked on a short supply of beets this year, but has had one of the most successful careers of any in the United States.

One of the remarkable incidents connected with the beet-sugar industry in this country during the past year was the building of that mammoth concern at Salinas, by Mr. Claus Spreckles, of California. This gives to the United States the largest factory in the world. Beets can be supplied to the sheds in carload lots and the cars emptied by a trip automatic platform. It has a monster silo pit for taking care of the pulp, which by-product has become one of the features of the California beet-sugar industry. The factory will cost $2,750,000. It will use about 1,200 barrels of petroleum daily for fuel. Its production of raw sugar will be about 400 tons per day. It will require about 30,000 acres of ground to produce the beets. It will work up about 3,000 tons of beets per day, and will pay out per day for beets about $13,000. It will be supplied with water from artesian wells, and will use about 13,000,000 gallons per day.

This factory was not completed in time for the campaign on account of the lack of a supply of beets caused by the drought, as mentioned before. The beets that were raised were shipped to the Watsonville factory, and as soon as it became apparent that there would be such a pronounced shortage of beets, the farmers were released from their contracts and were allowed to grow any crop they could on their soil. Lime quarries have been established near Salinas, furnishing a good quality of lime rock that will be used both at Watsonville and Salinas, and this is very fortunate for those concerned.

The factory at Santa Maria, conducted by the Union Sugar Company, Santa Maria, Cal., is said to have purchased over 4,000 acres of land, on which to grow its own beets. This factory is completed and equipped, and will begin operations next year.

The Hueneme or Oxnard factory was completed and equipped with a capacity of about 1,000 tons of beets, and is ready for the campaign of 1899. It is so arranged that the capacity can easily be increased. The factory is located at a little town called Oxnard, called into existence by reason of the factory's being established there. I understand it is the purpose of this company to give this factory a capacity of 2,000 tons of beets per day. The name of the Oxnard company is the Pacific Beet Sugar Company. The main building is 120 by 400 feet.

The Los Alamitos factory, before it began its campaign for the present year, increased its capacity from 350 tons to 700 tons per day. The indications are that the valley in which this factory is situated will have another factory in the near future. On account of the drought the factory secured sufficient beets only to run about seven days.

The Chino factory, operated by the Chino Sugar Company, Chino, Cal., has a capacity of 800 tons per day. The sugar content of the beets still holds up remarkably high at the Chino factory, the average being over 15 per cent during the campaign. After it was demonstrated that there would be a failure of a large part of the acreage of the beets, the factory decided to charge the farmers only for the seed that was planted on ground that actually grew beets. The factory sliced this year 47,302 tons of beets.

OREGON.

The factory at La Grande, Oreg., started up and demonstrated its ability to work up about 100 tons of beets more per day than it was originally designed for. This factory also failed to secure sufficient beets to give it a full campaign, having only about three-quarters of a full supply; but the campaign was sufficient to demonstrate its ability to do good work, also to prove that good beets could be raised in that locality in quantities sufficient to make the production profitable to the farmers.

UTAH.

The factory at Ogden, Utah, operated by the Ogden Sugar Company, also had a propitious beginning and considerably exceeded its designed daily capacity. The beets worked were of good quality, and it is demonstrated that the factory is rightly situated for a future success. The farmers are preparing to supply beets in the future to the full limit of its capacity.

The Lehi factory, conducted by the Utah Sugar Company, Lehi, Utah, had another good year's run, and is beginning to reap the benefits that come from a more practical understanding on the part of the farmers and factory people themselves of the problems underlying the raising of beets and their manufacture into sugar. The season was quite fair and this factory is taking its stand as one of the reliable sugar producers of the country.

One of the unique things about the Lehi factory is the fact that it was the first to start up a collateral industry to work on a by-product. Capitalists have established a distillery here, at an estimated cost of $50,000 and having a capacity to produce 170,000 gallons of alcohol per campaign. The proposition is that this distillery take the low-grade molasses after the sugar factory has finished with it and distill alcohol from it during about two months, and distill alcohol from rye during the other ten months of the year. Capitalists are also building up the cattle-feeding and creamery industry in connection with this factory; the production of seed continues to be an important feature.

This factory has also been conducting some experiments in the irrigation of beets. There is a tendency among the farmers to irrigate their beets too much and too long, and this year, when the beets had reached the point when, in the opinion of the factory people, they needed no further irrigation, the company proposed to the farmers to pay them 25 cents more per ton for beets if not irrigated any further. The factory people assumed the responsibility of all damages that might result to the farmer from this lack of irrigation.

NEW MEXICO.

All things considered, this was a very favorable year for sugar beets at Eddy, N. Mex., and the beets have kept up their high record, the sugar content in the beets ranging about 16 per cent. This factory has a capacity of less than 200 tons and is able to produce on its best days about 400 bags of sugar. The factory has from the beginning successfully conducted a stock-feeding enterprise in order to dispose of the pulp. They are feeding this year 1,100 head of lambs, which weighed at the beginning about 57 pounds and gained about 10 pounds per head in twenty-one days. The food ration consists of pulp and alfalfa.

NEBRASKA.

This was a good year for sugar beets in Nebraska. Moisture precipitation was favorable, and good crops were raised. The Grand Island and Norfolk factories both made successful campaigns. In Nebraska the production of beet sugar is no longer among the experiments.

MINNESOTA.

A new factory was constructed at Minneapolis, having about 300 tons capacity, in a suburb called St. Louis Park. The factory had some difficulties in starting, as almost all factories do. It failed to secure a sufficient acreage of beets to give it a full campaign, the amount being about one-third to one-half of its capacity. However, it mastered the difficulties, got under headway, demonstrated that it could place a good article of sugar on the market, and proved that in the section of the State in which it is situated profitable crops of sugar beets can be grown by the farmers. As a pioneer it is doing a great work for Minnesota in demonstrating that her flour industry will have a rival in the beet-sugar industry.

MICHIGAN.

A factory of 300 tons capacity was built and operated this year by the Michigan Sugar Company, Bay City, Mich. This was a good year for growing sugar beets and the acreage was quite sufficient to give this factory an opportunity to demonstrate what could be done in this industry in Michigan. The farmers are thoroughly convinced that it is the right thing in the right place, and the capitalists are convinced that they have found something to take the place of their waning lumber industry. The experiments that have been made in Michigan have uniformly demonstrated that beets superior in purity, quality, and quantity can be produced in that State. They have almost every condition that could be desired from the standpoint of a factory. They have good coal under their soil, immense quantities of timber fuel, streams of pure water in all sections of the State; they have the lime rock, cheap railroad and water transportation, with easy access to leading trade centers of this country, and they enjoy the advantage of competition in freight rates between the boats and railroads. They have large cities to draw on for labor of all kinds, and are near to a great many of the largest markets of this country. The same may be said of northern Indiana, Ohio, and Illinois.

NEW YORK.

The factory at Rome, N. Y., conducted its second campaign this year. Considerable expense was incurred in improving the factory by the construction of beet sheds and making internal improvements in the factory itself. The factory is in the hands of good representative business men, and gives every indication of a successful future.

There appear to be two drawbacks to this factory which may be overcome by good management and economy. One is the old design of the factory, it having been imported from Canada. Constant improvement will be required to keep up with factories of more modern design. The second is its small capacity, which is only about 200 tons of beets per day. This entails extra expense in producing sugar as compared with factories of larger capacity.

The factory at Binghamton, N. Y., operated by the Binghamton Beet-Sugar Company, started in its first campaign in the fall of 1898. Its supply of beets was probably three-quarters of what it will be able to work. The beets were good and the farmers of that section received a practical illustration of what can be done by growing sugar beets as a field crop.

Some of the commendable things about this factory are: First, it is very well built. No expense was spared to make it a very substantial structure. In fact, it is a model in this respect. Second, it was built entirely by home capital. I was impressed with the substantial interest which this fact inspired, not only in the proprietors themselves but in the whole community. I consider it one of the most favorable omens of success. Here we have a body of men every one of whom is as much interested in the work and business of the factory as the actual manager himself. The factory shows every indication of a successful career.

WISCONSIN.

In the foregoing are mentioned all the factories in this country that are now constructed and equipped for the business of manufacturing beet sugar, with the single exception of that at Menominee Falls, Wis. Some three years ago a factory was constructed and equipped with machinery of American make and design. Unfortunately this factory was the victim of several unfavorable circumstances, some of which are liable to occur to any of the newly constructed factories in communities where little is known and no experience in the industry has been acquired. These difficulties could be mostly avoided if carefully studied and analyzed by those interested in the enterprise. In this case one of the main difficulties was that insufficient time was allowed for building and equipping the factory and getting it ready for operation. The contracts were made with farmers, the beets were raised, all of good quality and purity, delivered to the factory and placed in immense silos. The construction of the factory was hindered by one obstacle after another, and its completion was thus delayed until, when it did start up, the beets had deteriorated by their long stay in the silos, and the warm weather of February and March coming on completed their destruction.

In many places in the factory inexperienced men were put where men of experience should have been. There was no time for testing faulty construction or placing of machinery; and, in fact, the machinery itself was designed and constructed without sufficient specific knowledge peculiar to beet-sugar machinery. But little sugar was made, and that of a poor quality; the result was a total collapse of the enterprise. It stopped business and went into the hands of a receiver, where it still remained when last heard from, which was recently.

The only test of the ability of this factory to do good work was this short run, and that was no longer than any other factory would have taken for a preliminary run to test the faults and errors of construction before the real campaign began. This failure was a very unfortunate circumstance for the State of Wisconsin. The locality has the right agricultural conditions for producing good beets and good tonnage. Undoubtedly, before long someone will study the merits of this factory, overhaul it, capitalize it, and start it on a successful career.

GENERAL INFORMATION REGARDING CULTURE AND USES OF SUGAR BEETS.

CONDITIONS REQUISITE FOR GROWING SUGAR BEETS.

A great deal has been said in farmers' conventions and institutes, in books and periodicals, about sugar beets. The nature of the plant, its botany, chemistry, and insect enemies, as well as the theoretical, practical, and scientific phases of the business have been discussed. As with a great many other subjects of this kind, before an experience and acquaintance with the subject is obtained, that is to say, before practical details have been learned by the people generally, we have advocates representing all shades of opinion, good, bad, and indifferent. These views are deduced from studying the results obtained in European countries in which results and experiences differ on account of the different conditions that prevail. Propositions based on European experiences are jumbled together and offered to the American people interested in the industry of raising sugar beets as the principles governing the status of that vegetable in this country. It is safe to say that hardly any of these propositions is more than partially true. We have agricultural conditions of our own differing from those of other countries. We have agricultural methods of our own which are superior to those of any other country. So, as we acquire more experience, we are establishing facts and building up a science of our own touching the growing of sugar beets of good quality and purity under our own peculiar conditions. There are some general conditions, however, that vitally affect the quantity, quality, and, in fact, the life history of the beet. These may be considered under the following heads: Nature of the soil, moisture, temperature, and light.

NATURE OF THE SOIL.

In this connection the soil should be studied from the standpoint of structure and physical condition and available fertility. The soil for sugar beets should be naturally of a light, friable kind—such as sandy loams, clay loams with sand, and soils which permit easily of cultivation and penetration. It must be especially remembered that hard impenetrable subsoils are not desirable. Hardpan is out of the question. The subsoil is of as much importance as the top soil, if not more. In the first place the sugar beet should embed itself completely in the soil. In the next place the taproots should go down deep into the subsoil. In a general way it may be stated that a soil is desirable that is opposite in character to the hard clay soils and black, mucky, waxy soils.

A soil may be fertile and yet lack some element which is necessary to make this fertility available. The choice of proper commercial fertilizers depends on the particular soil in question. A proper study must be given to the soil in order to render it of the best service in producing a crop of sugar beets. It is only fair to add that our soils generally do a great deal for sugar beets from their natural fertility.

MOISTURE.

By investigation among practical sugar-beet growers concerning the amount of moisture desirable for growing sugar beets I have learned that sugar beets will stand more moisture and get along with less of it than almost any other field crop. Although this statement is technically true, it must be taken with the following explanation: The sugar-beet plant at its beginning is one of the most delicate among the field crops. Wheat, corn, or almost any of the cereals sown in a dry time will wait for moisture, and when it comes will germinate and start off apparently not so much affected on account of this period of drought. It is not so with the sugar beet. It is likely to dry out, and the germ is liable to be killed if anything like this happens. It is also in jeopardy if planted during or just before a period of continued damp, cold weather. The necessary condition is that the beet seed should have sufficient moisture and sufficient warmth to germinate it and start it. After it has become a plant of three or four leaves it is ready to cope with the other field crops in standing excesses of different kinds. During the next two or three months excess of moisture does not affect it seriously; it will grow and develop. At the close of this period of growth the beet is said to have matured as to its form and size. The next thing that is necessary is an elaboration of the sugar in the beet. Through August, September, and October the least moisture possible is the thing to be desired for the sugar beet. Here comes in the application of the statement that it will get along with less moisture than any other crop.

After having about attained the size desirable the beet needs the cooperation of various influences in order that the sugar may be produced in it. Moisture is not one of these influences. Just here arises one of the difficulties in the raising of sugar beets in States that have fall rains, such rains as produce fall pastures and are quite desirable in many respects to the agriculturist, but which would be regarded by the sugar-beet grower with dismay. What we need during this period, and especially in September, is plenty of light and weather which is rather cool and dry. Late rains or irrigation result always in second growth. The beets send out laterals from the roots and new leaves. These leaves are produced at the expense of the carbohydrates or sugar, whose formation we are trying to promote in the beet, the elaboration of the sugar content of the beet stops, and the sugar already formed may be called for in this work of forming new leaves. Now, if we should add to such an unfortunate moisture condition a warm temperature, this growth of leaves and roots will only be accelerated. Thus it can be readily seen that fall rains are not desirable. Briefly recapitulating, the three periods for the development of the sugar beet are as follows:

The first, which might be called the germinating and plantlet period, from the beginning of planting up to the time when the plant attains, say, four leaves.

The second is the growing period, in which we establish the form and size of the beet.

The third is the period of sugar elaboration, which runs up to and includes the harvesting of the crop.

In the Mississippi Valley and the northern section of the country generally the first period would be from the 1st of April to June; the second period from June to the close of August; and the third, the last of August to the 1st of November, these periods all overlapping.

TEMPERATURE.

It is desirable that, at the time of germinating, the soil should not only be moist, but warm. The temperature that is desirable after that, it is claimed, is one that has an average of about 70 degrees during the growing of the beets, or second period. I believe an even temperature is quite desirable in order to produce the best condition for the beets, and yet I can not help thinking from results that have been obtained in some sections that too much stress has been put upon this matter of temperature. I think this subject has been discussed too much from the standpoint of results obtained in other countries. When we shall have established facts of our own with reference to this point, it may be found that there are localities in the South in which sugar beets can be grown successfully, and factories may be established in those localities to manufacture sugar from the beets grown there. Temperature is only one of the conditions, and it may be demonstrated that other favorable influences can counteract the effect of too high temperature.

LIGHT.

Beets and other plants have organs which perform a work corresponding to that done by the lungs in animals. These organs in the beets are situated in the leaves on the underside. The idea will therefore suggest itself that beets which have larger leaves, well spread out, have a better opportunity for working on the air, and therefore a better opportunity for producing the sugar in the beet. Air and light are essential factors in satisfactory plant growth and especially necessary to the formation of sugar. Hence this stage is greatly accelerated by the action of light and unobstructed sunshine. This explains the necessity for long, cloudless, bright days during the period of sugar elaboration, which constitutes the last period in the life history of the sugar beet; also the desirability of a complete absence of noxious weeds and other foreign material which may interfere with the free access of light and air to the leaves of the beet.

GENERAL SUGGESTIONS FOR RAISING SUGAR BEETS.

Long experience in the cultivation of the sugar beets has furnished certain rules which are general in their application and which govern the preparation of the soil, seeding, thinning, and cultivating the beet plants. Some general requirements are here given, and some others that have local application are suggested. Reasons for the requirements or rules are also given in some instances.

PREPARING THE GROUND.

In order to produce a beet of right form and pure throughout, the soil must be such as will permit the beet to penetrate it readily with its taproot and also permit it to embed itself wholly therein. If this is not the case, the tendency of the beet is to "sprangle" out, which it should not do. It should have a single taproot, which tapers off into a long, thread-like appendage, striking down deep into the subsoil. The beet should grow under the soil as much as possible, and the top portion should not stick out above the surface, as this is not only deleterious to the whole beet, but makes it necessary to cut off that portion which projects above the ground before the beet is sent to the factory, causing that much loss to the grower.

The soil should usually be plowed about 8 inches deep, the plow being followed by a subsoiler that loosens up the earth to the extent of 7 inches more. Then it should be harrowed back and forth until it becomes thoroughly pulverized and softened. This condition is necessary to germinate the seed and assure ourselves of a stand of beets. If seeds are sown in ground where the surface is lumpy and cloddy, even if the lumps are quite small, the effect is bad. The seeds are sown from a half inch to an inch in depth. The beet seeds, having a rough, dry husk with convolutions on the exterior, must be planted in a soil that is soft, so that it will press against the sides of the seeds, filling up the little depressions, thus inducing capillary attraction to bring the moisture from the soil to be absorbed by the seed, causing germination. On the other hand, small clods are likely to keep open little channels around the seed through which the dry air circulates and dries out the seed so that it finally dies. Thus the opportunity for securing a good stand is diminished, as well as the chance of securing strong and healthy plants at the outset, all of which emphasizes the importance of a highly pulverized soil.

It is usually the practice in stirring up the ground preparatory to planting sugar-beet seed to do the first plowing in the fall. The subsoiling is also done at this time. In the colder regions we thus have the benefit of freezing and thawing, which crumble and pulverize the soil, as most farmers are aware. In the spring the ground is plowed again with a shallow, stirring plow or a good cultivator, and this is followed by harrowing, etc., to prepare the surface.

In the sugar-beet districts of California it is the rule for the farmers to do the larger part of their cultivating in the early spring. In fact, they aim to kill all the weeds they would otherwise have to contend against before the beet seeds are planted. The conditions there are more advantageous for this purpose than in most other sections, because the winter rains and early warmth cause the grass and weed seed to germinate so that when the ground is cultivated the weeds are killed. A second crop of weeds is then allowed to start and the ground is cross cultivated to kill them. This also helps to get the soil in condition for planting. After planting there are no further rains and consequently no such opportunities for weeds to grow as there are in States where it frequently rains. We have, however, found sugar-beet growers following this method of killing weeds to some extent and with good effect in the Mississippi Valley, where weeds grow luxuriantly during the growing season of the beets.

PLANTING.

Special implements or drills are used for the purpose of sowing sugar-beet seed. Some of these implements have special arrangements for sowing the seeds in ridges and others for planting them on level ground, the latter being more usually the custom in this country. There are places in the United States where the conditions will permit planting beets in ridges, and these ridges may be maintained throughout the cultivation with apparent advantage to the beet in facilitating the action of the air and the sun; but we believe this planting is not considered good practice in most of the present sugar-beet regions. Where seed is to be sown on a large scale it is preferable, at least more economical of time, to use the four-row seeder, which can be regulated with much precision for sowing a definite number of pounds of seed to the acre. The best practice in this country appears to be to sow from 15 to 20 pounds per acre, with a leaning toward the latter amount. It is better to be a little out of pocket on account of seed wasted than a good deal out on the quantity of beets grown owing to a poor stand.

PLANTING AND CULTIVATING IMPLEMENTS.

The companies that make a specialty of implements for the cultivation of sugar beets have what they call a "full set of tools." In cases where the four-row seeder is used, a four-row cultivator is a part of the set. This is desirable from the fact that the cultivator follows the same four rows and in the same order that the seeder planted them, so that if there is any variation from a straight line the same variation will occur in each of the four rows. The person who is holding the cultivator handles has only to watch one row, and if it becomes necessary to shift the implement to one side or the other on account of a variation in that row, the same will be true of the other three rows. The implement companies have also a set of two-row implements that operate in the same way. The cultivators used in this country are usually drawn by one horse or mule. Most of those who have had experience with both animals prefer the mule for this purpose. It is claimed that the mule is more compact in proportion to his power, and having smaller feet, when the width between the rows is narrow, say 14 inches, he is not so liable to injure the beet plants. It is also claimed that the mule is more susceptible to training in this particular line of work, especially in following the rows faithfully. He needs less attention from the person holding the handles of the cultivator, who thus has more time to devote to cultivation. This one mule or horse is all that is needed to pull the cultivator, taking four rows at a time. After the seeds are planted it is usual to roll the ground, and by this means compress the soft dirt thoroughly around the shell of the beet seed, as has been suggested. This practice serves well to accomplish this purpose. But in some localities it is found to be undesirable to retain this smoothly rolled surface, and to prevent evaporation it is "roughened up" by the use of a harrow. This is done where the soil is quite sandy and the prevailing winds are very strong in the spring, because where the ground is very level the wind carries along with it over the smoothly rolled surface small sharp particles of sand which strike the sugar-beet plants, often cutting them off even with the surface.

The first cultivation is accomplished with small plows or knives attached to the cultivator, called "goose feet," because they resemble very much the form, shape, and size of a goose's feet. The edge of the knife runs within 1½ to 2 inches of the beet, a knife running on each side of the beet plants in each of the four rows, the side next to the beet presenting a square surface. The cutting part of the foot runs from one-half to an inch below the surface, and parallel with it. It is not the intention to stir the soil to any depth, but simply to run the knives under the surface for the purpose of cutting off the roots of the weeds and grasses and breaking up the crust of the soil. This is the usual practice in the early stages of cultivation. Later it is usual to replace the "goose-feet" knives with "bull-tongue" cultivator blades, so named from their similarity in form to a tongue. These cultivate down 3 to 6 inches.

THINNING AND BUNCHING.

It is customary, as soon as the beet plants get through the ground so that the rows can be readily discerned, to go over the field once with the cultivator with the "goose-feet" knives attached. This catches the first weeds in their early stages, breaks up the hard surface, and permits bunching and thinning to better advantage. Bunching is resorted to to save time and labor. A person goes along the rows and with a sharp hoe cuts out most of the surplus plants in the row, leaving the plants in bunches from 6 to 10 inches apart, as may be desired. He is followed by another who does the thinning. He crawls along the rows on his hands and knees, and, selecting the most thrifty plant in a bunch, takes it between the first two fingers, with the back of the hand toward the ground; then with a quick movement of the fingers of the other hand he grasps the surplus plants and removes them from the soil. This is one of the most laborious features of sugar-beet raising. It can be done by boys and girls from 12 to 16 years old, who are very active in the work. In fact, this kind of labor can be used to a great extent all through the various stages of cultivation of the beet. I have known farmers in their earlier experience with raising sugar beets who looked upon this thinning out as a great waste of seed, and who tried the experiment of planting less seed the next year. This experiment usually ended in disaster, especially if the conditions for germinating the seed happened to be unfavorable. It is not often that a farmer repeats this experiment.

THE TIME FOR THINNING.

It is a very serious mistake to allow the plants to become too large before they are thinned. The "agriculturists" at the different factories are particular on this point when scanning the work of the farmers who are growing beets for the factories. There is a tendency of the plants where they are grown close together to twine around one another, and the principle to be observed in thinning beets is to remove the surplus plants in such a manner as to leave the plant that is to mature firm in the soil, disturbing its roots as little as possible. If other plants are twined about the one that is to remain, the larger these intwining plants become the more the intwined plant is disturbed in thinning. The beet plants send out their lateral roots very rapidly, and in thinning out the surplus plants these are liable to be more or less disturbed. The larger the beet that is to remain in the soil the more likelihood there is of its being disturbed; hence, this thinning process must not be neglected. The beet plants that are to remain can be set back three weeks by such neglect, and in a dry season a number of the plants are likely to be killed, thus affecting the "stand."

CULTIVATION.

Cultivation has already been discussed to some extent. Harrowing is to be very strongly recommended in the cultivation of sugar beets. Three things must be kept in view in cultivation: First, the beets must be kept absolutely free from weeds and grasses, so that the beneficial effects of the sun and air may be fully realized; second, the ground must be kept loose for the same purpose; third, in case of dry weather the soil must be kept stirred, in order that a dust mulch may be sustained to prevent evaporation of moisture. Frequent hoeing by hand is highly beneficial to the crop.

HARVESTING.

The time of harvesting is governed by the time of ripening of the beets. This ripening is made apparent by the outside leaves of the plant taking on a yellowish tinge and drooping to the ground. An experienced eye soon learns to detect a field of ripe beets that is ready for harvesting. The beets having now finished their work, the next step of the grower must be governed by his locality. If he is in a section where there is a probability of rain, the beets must be harvested and placed in silos. This should be the case in most of the the sections where rain conditions prevail. Such places usually have heavy rains in September and October, followed by more or less warm weather. The effect of the rain will be to cause the beets to begin growing again, and, if the rains are heavy and followed by warm days, it is possible for a whole crop to be lost so far as fitness for factory purposes is concerned.

SILOS.

It is the custom in such localities to haul the beets to the factory if possible. If it is not possible to do this, they are gathered and placed in long ricks or piles on the surface of the ground. The bases of these ricks or piles are from 3 to 3½ feet wide and the height from 3 to 4 feet, tapering toward the top. Along each side of each rick several furrows are run with a stirring plow in order to loosen the dirt. The ricks are then completely covered with this dirt by the use of shovels. This covering is put on to the depth of about 6 inches, occasional air spaces or ventilators being left on the tops of the ricks, for which purpose are commonly used tiling or small elongated wooden boxes or simply straw, the object being to prevent fermentation.

Storing the beets in this way is called "siloing" and the ricks or piles are called "silos." These silos are closely watched, in order that no heating may occur to cause fermentation, which lessens the sugar content of the beet. The ricks are opened occasionally by way of inspection. It is the aim of the grower, as already stated, to get the beets to the factory as soon as possible, but this will depend on "his turn." In case he is delayed in this way until cold weather comes on, these silos are covered with straw, manure, or something of that sort, and then an additional amount of dirt is thrown on the straw covering. In this way it has been found that the beets will keep in very good condition until the last of January, if necessary.

It might be stated in this connection that it does not necessarily follow that the beets are lost even if they should be frozen solid, as the factories can readily work them frozen, and, in fact, some factory superintendents say they prefer to work frozen beets. The one thing to be guarded against in the case of frozen beets is thawing. In California, where rains or freezing are not liable to occur, after the beets have ripened and have gone into this state of rest they are allowed to remain in the field until the grower is notified by the factory that his beets must be delivered, when they are harvested and taken to the factory. Thus the expense of siloing is avoided.

HARVESTING IMPLEMENTS.

Harvesting is accomplished by means of an implement especially prepared for the purpose. I have seen several kinds of these implements, all of which seemed to do the work admirably. In some places it is done by means of a long, slender plow, with a sharp plowshare, which works on the principle of the stirring plow. This plow is run close to the beet in such a way that the share cuts the taproot just below the enlargement of the beet, at the same time loosening, lifting, and laying it on its side. Another harvester, instead of having a share, has two prongs, one of which passes on either side of the lower portion of the beet root; the space between the prongs decreasing from the front backwards causes the beet root to be forced into the smaller space between these prongs as they pass along the row and the beet is thus lifted bodily 3 or 4 inches and the taproot broken. As the plow passes on the beet drops back into its place loosened and ready to be lifted from the ground by the hand. Following the plow are persons who pick up these beets and by one stroke with a large knife made for the purpose cut off the crown of the beet together with the leaves. This is called "topping," and it is the aim of the person doing this "topping" to make the cut at the line showing that portion which has projected above the ground. Where the beet has been grown entirely under the ground only enough is cut off to carry with it the crown and the leaves. If the beets are to be sent to the factory at once the "topper" simply throws them in piles, from which they are placed in sacks and put in wagons for delivery to the factory. They are sometimes thrown loosely into the wagons from the piles. Most of the factories, however, have arrangements for quickly handling the beets. Some of them have wagons provided with nets for receiving the beets, and upon reaching the factory these nets are taken from the wagon by the aid of machinery and their contents dumped into the beet sheds. At other factories the wagons are hauled up an elevated driveway to a "dump," the tipping of which precipitates the load of beets into the beet sheds. The advantages of such arrangements can be appreciated when it is known that frequently long lines of wagons loaded with sugar beets stand ready at the factory to be handled. Either of these arrangements quickly disposes of many wagon loads, and teams are not required to wait long, as would be the case if unloaded by shoveling out of the wagons into the shed. Still shoveling is resorted to in some places.

IRRIGATING.

It has been stated that beets can be grown successfully under irrigation conditions, and in fact two factories in the United States, one located in Lehi, Utah, and the other at Eddy, in the Pecos Valley, New Mexico, secure their beets entirely through irrigation. There is a large amount of land available for the raising of sugar beets by irrigation in Colorado, Utah, Montana, Wyoming, western Nebraska, and other States having like conditions; and this industry is one that should appeal to the people of these sections on account of their already well-known grazing resources and the fact that stock feeding and dairying are so intimately related to the beet-sugar industry.

The first beets that were ever successfully raised by irrigation for factory purposes were grown at Lehi, Utah. I believe it is maintained in Europe that beets can not be successfully grown by irrigation—at least it is seriously questioned—but the experience at Lehi, Utah, and Eddy, N. Mex., has forever exploded that theory. There are a few things that must yet be learned about the application of irrigation to growing sugar beets, but the obstacles are fast being overcome, and the two factories mentioned are teaching the world lessons along this line. In doing this they are also demonstrating the possibilities of the vast resources of all the territory in the West having like conditions. Irrigation is especially adapted to raising sugar beets where the particular region is favored with rainfall at planting time. The ground is moistened by rain, and the seeds are germinated and started on their first growth. Experience has demonstrated that irrigation should be held off as long as possible and applied as little as possible. Water should not be applied by irrigation until the natural supply has failed, and even then the grower must be careful not to apply too much, which is as disastrous as not enough.

I have learned by talking with those experienced in the application of water by irrigation that the land tends to dry out quickly after being irrigated and to become packed; hence cultivation must follow as soon as practicable after irrigation. It has been noticed that the beet has a tendency to send down its taproot deep into the soil, and especially is this true in the earlier stages, if the necessities of the case demand it, in order to procure moisture. But if the water is applied too lavishly in the beginning this tendency of the beet is arrested, and it shows a disposition to rely on the artificial supply of moisture near the surface rather than to seek its own at greater depths. Thus irrigation may interfere with a natural tendency that is desirable in the growth and maturity of the beet. The effect will be, under these circumstances, that the taproot will divide and the beets will become bunchy and sprangled, assuming a form entirely undesirable. The beet may show a tendency to slightly droop its leaves and to become lighter in color, but this does not indicate that irrigation is needed. Irrigation must not be resorted to until necessity demands it. Wilting of the leaves or curling up of the same does not necessarily indicate need of irrigation. If the beet recovers its vigor in the evening it is a sufficient indication that it is getting along all right. When it begins to suffer from drought the tendency will be to droop and get darker in color, and it will not apparently recover in vigor with the approach of the cool evening. This is the time to consider the question of applying irrigation.

I have observed two methods of irrigating beets, either of which seems to accomplish the work successfully. One of them is to plant the beets in rows, say from 18 to 20 inches apart, and, when it is desirable, to turn on the water to run a small furrow in every second "middle" by the use of an implement made for this purpose. The water is then turned on and allowed to trickle down these furrows. This causes the water to pass down on one side of every row in the field. When it becomes necessary to apply water again the furrows are made in the "middles" not furrowed before, the former furrow having been leveled out by cultivation. The second plan is to plant the first two rows the usual width apart, say 14 to 20 inches, and leave the space between the next two rows considerably wider, say 26 inches, and so on throughout the field. The wider space is left for the purpose of having an irrigation furrow, which is made in the same manner as described above. In either case water can be held in these furrows by throwing a shovelful or two of dirt into the furrow in front of the water until the ground becomes thoroughly saturated around the beets; then the obstruction is removed and continued down the furrow. Of course the supply furrows are conducted along the higher places and the cross furrows arranged in such a way that all parts of the field may be reached. The grower who applies water by irrigation must thoroughly understand the science of economically distributing the water in the field. This is a question too broad to be entered into here, but by experience the farmer becomes more or less adept.

In regions where the beets are started in the spring with moisture from rainfall it is the aim of the grower to produce his crop with four or five irrigations of the beets. After they begin to ripen all irrigation must cease, for the same reason that makes it undesirable to have rainfall after the beets are ripe.

BLIGHT IN BEETS.

I noticed during the inspection last summer that in some sections, especially in the arid regions, where beets were raised by irrigation, the beets are liable to be affected by disease or blight. This disease seems to attack the taproot at a considerable distance under the surface and then gradually work up through the body of the beet, the lateral roots feeding the beet and keeping the leaves green during the progress of the disease. The diseased part rots completely, and finally the whole beet is consumed in this way, the disease generally completing its work when the beet is about two-thirds grown. After this the leaves die, the disease having consumed the beet and thus killed the lateral roots which fed them. A very sour odor can be detected during the prevalence of this disease. I am not prepared to say whether this blight is peculiar to irrigated beets or not, but I found the disease throughout the regions where the beets were grown by irrigation. I found irrigated fields, however, where the crop was not affected in this way and some fields which were only slightly affected. If the disease is due to irrigation, the people who irrigate will have to find out by experimenting how to overcome it. The trouble appears to be caused by intensely hot weather and irrigation combined. Hence it had occurred to the writer that if the colder days and nights were selected as the time of irrigation as far as possible it would be better for the beets. On this point Mr. Cutter, of Lehi, says:

> Irrigation has nothing at all to do with the blight of root on the part of beets. There has been blight of beets in several localities this year, whether irrigated or not. It is simply a secondary consideration, the primary cause being the lack of moisture.

SUGAR-BEET INSECTS AND DISEASES.

This year has also brought another fact very forcibly before the sugar-beet growers, and that is that this crop has obstacles and enemies in its way as well as other crops. From all sections of the country where sugar beets have been grown reports come with reference to different enemies that prey upon the plant, such as cutworms, caterpillars, aphides, beetles, beet-leaf jaundice, etc. The beet grower will have to consult authorities on entomology to find out the different remedies to meet these troubles. To combat them is simply a part of the labor necessary to raise a crop of sugar beets, and it will be found that there are sufficient remedies at hand if practically applied.

FACTORY CONDITIONS.

Conditions that affect the ability of the agriculturist to profitably grow sugar beets have been considered; but in considering the beet-sugar industry there is another side to the question, which might be called the factory side. It may be possible to grow sugar beets successfully and yet the local conditions may not be favorable to operating a factory, and without a factory the farmer has no market for his beets. He can only use them as a food for stock. So we will next consider some of the necessary factory conditions.

WATER FOR THE FACTORY.

In some localities we find all the conditions favorable for constructing a factory, such as sufficient quantity and quality of beets, shipping facilities, cheap limestone, etc., except that the water supply is limited or not of the right quality. It has been found practicable in some instances to purify the water by the use of lime and other compounds; for instance, after water has been used in washing the beets and for other purposes around the factory it is conducted off into a receptacle, the foreign material, such as dirt, pieces of beet root, tops, leaves, etc., is strained out of it, and it is purified and taken back into the factory for use again. I believe there is one factory out in California that gets a large part of its water supply by bringing it down in barges by means of a towing vessel.

BUYING OLD FACTORIES.

The experience of the factories that are now in operation in this country, if thoroughly analyzed, will demonstrate that it is absolutely impracticable to buy an old factory in some foreign country, move it here, set it up, and go into the business of manufacturing sugar from sugar beets in competition with machinery of modern design and make, either from Europe or America, especially from the latter. So much has been accomplished in the last few years in the way of perfecting the process of manufacturing sugar by means of invention in machinery and the elimination of clumsy and useless parts that old factories lose seriously in the time and expense employed in comparison with those which employ machinery of modern make. It is also evident that a comparison made between machinery of foreign make and that of American make would result in a verdict favorable to the latter. The natural mechanical genius of the American people will advance this industry, as history has shown it to do in all other branches of manufacture. This is not said in any spirit of braggadocio; it is only stating a fair proposition when we assert that the mechanical genius of the American people will work wonderful changes in the processes and machinery used in the manufacture of sugar from sugar beets in the next ten years.

THE SUGAR BEET IN CHARITY.

Some philanthropist out in California conceived the idea of giving employment to the unemployed in the city of San Francisco by means of controlling a large tract of ground on which could be grown sugar beets. The idea materialized by the Salvation Army's securing a large tract of ground for this purpose. This organization seeks to induce persons out of work to take employment on this tract at so much per day in cultivating, thinning, and other work on the beet crop during the season. Employment has been given to quite a number in this way.

In New York State officials in charge of penal institutions have tried to conceive of some scheme by which convict labor could be suitably employed, and it is seriously proposed that the State should secure control of tracts of land and put the convicts to work in this enterprise, furnishing sugar to the other State institutions.

The Chamber of Commerce of Denver, Colo., has been working actively during the past year in stimulating interest in different sections of the State with a view to starting several factories. In other cities this subject is attracting more or less attention. The more investigation that is given to the benefits that might accrue to the people of this country by establishing the beet-sugar industry on a larger scale, the more it will appear that it is becoming a necessity.

GOOD ROADS.

In establishing a factory at any given point there is one thing that must not be lost sight of, and that is the highways. There is no one thing that contributes more to the peace, comfort, and economy of a well-regulated factory than good roads. When a factory is located it should be seen that roads are opened up from different directions. If a good roadbed has not already been constructed it should be attended to at once, since these roads must largely be used in hauling heavy loads, farmers finding it desirable to put on several tons in hauling beets to the factory and taking the pulp home.

FERTILIZERS.

The question of fertilizers as affecting the culture of sugar beets in this country is not so important as some others, except in some sections where the soil has been a great deal longer under tillage than it has in the Northwest. One of the advantages this country has over Europe is the fact that there they must necessarily resort to expensive fertilizers, costing $10 to $20 per acre, in order to produce a crop of beets, while in a large section of this country where sugar beets have shown an adaptability to agricultural conditions no fertilizer whatever is necessary. While the particular constituent elements, in which we are mostly interested, come from the air, the beets must necessarily draw from the soil some of the agents needed to perform the work of transforming the carbon compounds into sugar in the beet, our soils will furnish for some time a bountiful supply of these agents.

One of the most common mistakes made by the farmer in the use of sugar-beet fertilizers is the attempt to apply his experience with fertilizers as affecting other field crops in producing sugar beets. This necessarily leads him to an improper application of the nitrogen compounds to the soil, such as that found in barnyard manures and decaying vegetation of all kinds. But this is a mistake. If any nitrogen should be applied to the soil at all, it should be applied two or three years before in growing other crops in the order of rotation.

This may be found necessary in some cases on account of the weakness of the soil, in order to produce a beet of sufficient body and size. The effect of nitrogenous fertilizers in the matter of increasing the sugar content is deleterious rather than advantageous. The elements needed more particularly in reenforcing soil are the potassium compounds and phosphates. There was a time when the use of potassium was seriously questioned, for the reason that the sugar beet is found to contain as one of its constituent elements potassium largely increased in proportion as it is furnished by the soil, and this potassium interferes very seriously with the work of crystallization in the case of some of the lower sugars in the process of manufacture. The process has been very materially improved and this element no longer affords the impediment that it did previously.

Under the head of fertilizers I would like again to call attention to the availability of the various elements in the soil, induced by the condition of the soil itself when the beet plant is calling upon it for material. I refer to that condition of the soil brought about by fall plowing, especially in our western and northern districts. Every farmer is acquainted with the fact that when ground is plowed in the fall and becomes saturated with water from fall rains or early snows, and freezing goes on during the winter, the consequent expansion of the particles of the water in the soil on account of its being frozen into ice produces thorough disintegration and mellowing of the soil itself. This makes available the food for plant life, and therefore accomplishes the same purposes as fertilization itself. Fall plowing can not be too strongly urged for growing sugar beets, since a thoroughly pulverized mellow soil is absolutely necessary in the earlier life of the beets.

THE MANUFACTURE OF ALCOHOL FROM THE SUGAR BEET.

With a view to giving the people of this country as thorough a notion as possible of the scope and magnitude of the sugar-beet industry, I propose to include in this report a discussion of the various uses of the sugar beet and its by-products. It will probably be a matter of surprise to a great many people in this country to know that the sugar beet is used extensively in some countries, and especially in France, for the production of alcohol by distillation. In France alone the annual output of alcohol is 20,000,000 gallons. These figures are not startling in themselves, but they bring into view the fact that the sugar beet is a competitor with other farm products as a raw material in the manufacture of alcohol. Since this country manufactures alcohol profitably, and we know that there are vast sections which have advantages for producing sugar beets that are quite superior to those of France, the question naturally forces itself on us: Why not study this phase of the sugar-beet question? Here is an opportunity for the employment of our capital in the manufacture of alcohol, and not only so, but it would, moreover, afford to the farmer an opportunity to extend his own operations in beet raising so as to raise the crop of sugar beets necessary to the manufacture of this alcohol.

The process may be briefly described as follows:

The beets having been hauled to the distillery, they are then thoroughly washed, cleaned, and sliced, the process so far not differing from that followed in a beet-sugar factory. The next step is to place the slices or cossettes in a battery of wooden vats. These vats are connected by pipes and are so constructed as to permit the juices to pass through the bottom. Juices are formed by means of water entering the first vat and then percolating from one vat to another in succession. Light solutions of sulphuric acid are placed in these vats. This is done with the ultimate object of producing sugar in the form of glucose. This object having been accomplished and the juice containing the sugar having been reduced to the form of glucose, the subsequent operations consist mainly of fermentation. It is, of course, necessary to keep the temperature of the juice at a point which will best maintain fermentation and thus subserve the operation. The rest of the operation consists simply of distillation, which it is, of course, unnecessary to describe in detail. It is sufficient to explain that, as it requires a temperature of 212° F. to boil water and one of 172° to boil alcohol, it is only necessary to keep the juice heated to a temperature above 172° and below 212° in order to drive off the alcohol in vapor. This is collected by means of a tube and required to pass through a still in the form of a coil of this tube, by which the vapor is condensed into the form of liquid alcohol.

Of course, I have here given only a rough sketch, as there are many intricacies entering into the process of getting all the alcohol out of the juice. Enough, however, has been said to serve the purpose of giving a general idea of the work. It is only necessary to add in this connection that the pulp refuse of the sliced beets is very valuable stock food. Though the sugar has been taken out, the pulp contains practically all the other elements of food that it had before. It has been stated by experienced authorities that for every 100 gallons of alcohol taken out, sufficient pulp has been produced to feed 50 head of cattle for a period of not less than twenty-four hours.

EFFECTS ON ANIMAL INDUSTRIES.

FEEDING SUGAR BEETS TO STOCK.

One of the things that is seriously lacking in this country is knowledge on the part of the farmers regarding the nature and habits of the sugar beet and the cultivation that applies thereto. There is a sameness in the growing of most field crops, and the farmer naturally inclines to include beets in this general treatment, but this must not be done. The care and attention required to produce a crop of sugar beets cost more than most other crops sell for per acre, that is to say, $25 to $30, and in especially weedy districts it will cost even more than that. The treatment of the soil, the planting, cultivation, harvesting, etc., are all different, being based entirely upon the nature of the plant and what is required of it. But I have a suggestion to make that I feel will gradually accustom the farmers to the nature and production of sugar beets—one which almost every farmer in the country can take advantage of, and especially those living in localities probably favorable to the growth of sugar beets. I would suggest that every farmer grow sugar beets for the same purpose as other crops, namely, food for man and beast. For the table there is no more palatable beet than the sugar beet rightly prepared. It is excellent for the milch cow, for fattening hogs, and for fattening steers and sheep. There is nothing that excels it; and for the same labor, the same expense, and the same dimensions of ground there can be nothing produced that will give better results to the farmer for stock-feeding purposes. The best conditions for raising sugar beets for stock purposes are in those districts where the sugar beet can enter into the food ration along with grains and other stuff. Another thing in its favor as a product for general farm purposes is that we can raise a crop of sugar beets when almost everything else fails on account of lack of moisture.

Some wonderful results have been produced by feeding sugar beets. Here is one illustration: A gentleman in California is an extensive grower of fruits, which he prepares for the market in the shape of dried fruits, such as dried prunes, dried pears, and raisins. Now, it appears that in the production of these commodities he has a great deal of waste, such as inferior fruits, batches spoiled in the process, etc., which he utilizes in feeding different kinds of stock. Experience taught him that he could handle hogs easier than anything else to consume these wastes, but he wanted something more substantial to feed with them, so it occurred to him that he would utilize the spaces between his young nonproducing trees in growing a crop which would not grow very high, and so would not interfere with his orchard. He commenced growing sugar beets and feeding the same in connection with these waste fruits. His feeding industry grew, so that when I saw him he had about 500 hogs that would weigh from 350 to 400 pounds each, and no finer specimens could be found. They were superior in every way for the market. These hogs had been put in this condition without an ounce of grain of any kind. As I understood it, his ration consisted of bran, waste fruits, and sugar beets. The ration is prepared in this manner: He secured a machine that would grate the beets up fine; then he mixed a definite quantity of these ground beets, waste fruit, and bran, and cooked the whole in an apparatus which he had carefully prepared and designed for that purpose. Mr. Allen, of Ames, Nebr., secretary of one of the most extensive cattle-feeding companies, raised 500 acres of sugar beets simply to feed his cattle, and I understand he raises a large quantity of beets for this purpose every year. They are being raised for stock food extensively in Illinois and other sections of the country where their value as a food has been tested and appreciated.

I would like to suggest in this connection—in fact, to urge upon every farmer who reads this article—the propriety and great practical value of trying the experiment of growing sugar beets for stock feeding. As a sanitary measure it will pay its way. I believe that the habit of the farmer in feeding condensed rations of grain to stock is largely responsible for a great many diseases of animals, and that if he would introduce into this ration a portion of sugar beets results would be a great deal better as far as the health of the stock is concerned. As an aid to digestion it has certainly wonderful effects, to which fact every extensive feeder of sugar beets will give testimony. My attention has been called time and time again to the fact that cattle fed grain along with sugar-beet pulp or sugar beets are able to digest all the grain they eat, and the refuse shows no whole grains. Taking, then, its sanitary value along with its real nutritive value as a producer of flesh, we are able to appreciate its value as a food.

Lastly, I wish to impress more forcibly on the attention of the farmer the fact that he will gradually become better acquainted with the nature and growth of the sugar beet, and when it is proposed to establish a sugar factory in his district he can enter more intelligently into the proposition and arrive at safe conclusions in regard to it. He is better able to figure up the cost and profits or loss. Sooner or later this question is coming home to every farmer who lives in a locality which has the right conditions for producing sugar beets of sufficient quality and purity for the manufacture of sugar. This industry is bound to grow and extend to its full limit in this country. It means too much to us to set it aside. Our conditions and possibilities in this direction are too great to overlook. It would be suicidal to do so, and it is well for the farmers to begin now to grow sugar beets. For the purpose of stock feeding a farmer can easily grow 15 to 20 tons per acre, and it is an established fact that they are worth three-fourths as much for stock as for sugar. Experience confirms the proposition on every hand. Of course not so much care, expense, time, or experience is required in growing them for stock as for sugar purposes, but in this way the farmer will get acquainted with them and be better prepared for growing them in the future.

A great many things that are beneficial to the farmer follow in the wake of every factory. It affords the very best opportunities to the creamery industry and to stock feeding of all kinds in its supply of pulp which results from the extraction of the sugar from the beets.

This is one of the most desirable of stock foods, can be obtained cheaply from the factory, and is easily stored and kept. The factory opens the way to the manufacture of alcohol, the manufacture of fertilizers, vinegar, shoe polish, and other things.

To the farmer I say, make the acquaintance of the sugar beet. Grow it, feed it, and encourage the sugar industry. The sugar beet is extending to the farmers who live in the right localities the most friendly greeting of any product I know of that can be grown on the farm. It is this feeding value of the beet, and especially of the pulp, that is going to make the beet-sugar industry master of the situation as compared with the cane-sugar industry. With all the fertility and cheap labor of Cuba, Porto Rico, and the Philippines, the Western and Northern farmer, with his sugar beets and the by-products incident to their manufacture into sugar, can successfully compete.

I have studied this sugar problem in Cuba and Porto Rico (on the ground), and the industry is languishing not only in those islands, but in all the tropical islands and countries, those of England with the rest. The sugar producers are all discouraged in their attempt to compete with the sugar beet of Germany, France, Austria, etc.

Here are some statements made by those who have experimented with sugar beets as food for stock.

Dr. Cresswell, of Colorado, in giving his experience in feeding sugar beets, says:

> I took 50 Colorado range steers and fed them for 100 days on sugar beets and alfalfa to prepare them for the market. I gave them 8 pounds of beets a day and all the alfalfa they could use, and gradually increased the amount to 15 pounds of beets a day. The last two weeks I fed them on corn and straw with the beets, which hardened the beeves so they could stand any kind of shipment. They gained an average of 3 pounds a day. Again, I took 40 head of young Texas steers and fed them on sugar beets and alfalfa, and they added considerably more weight, thriving far better than those fed on alfalfa alone.
>
> After seventy days I turned these young steers with the remainder of the herd, and they could easily be told from the rest. They were larger and heavier and shed off in the spring much better than the others. I believe there is good money in feeding beets with alfalfa, not only for fattening purposes, but also for growing stock. Alfalfa is rich in nitrogen, and after thirty days' exclusive feeding a great proportion of the nitrogenous value is not assimilated, and is consequently lost. Combined with sugar beets, the nitrogenous value is retained for an indefinite period. Corn is excessively rich in carbonaceous elements and wanting in nitrogen; therefore the two go well together.

An extensive sheep feeder named Thomas Smart, at Logan, Utah, who has been giving some attention to the feeding of sugar beets to sheep, has made a proposition to the farmers to take all their beets refused by the factories on account of the size and quality, buying them for the same price that the factory pays for the beets. This is another illustration of what the feeder will do when he learns the value of beets or pulp for feed.

PULP FEEDING.

In other places in this report will be found detailed statements of experiments in the feeding of pulp of sugar beets. I am convinced that this question of pulp feeding can not be too carefully considered by the farmers of this country when they are weighing the facts and the benefits that will accrue to themselves by establishing the beet-sugar industry. It has been the endeavor all through this report to show up the benefits that will accrue to the American farmer by growing sugar beets for the factory, because as a crop it is so much more profitable and surer than almost any other field crop. But I am not at all sure that the secondary benefits that follow the establishment of a factory in a farmer's locality are not really as beneficial to him as the main crop itself. I refer to the opportunity he has for feeding pulp, one of the cheapest and most nutritious stock foods that can enter into the daily ration of any animal fed for almost any purpose. The same is true of sugar beets which are raised purely for stock food. The only difference is that pulp, after the sugar is taken out, is about as nutritious as the original beet with its sugar content, and of course it is more economical to a farmer to raise beets, sell the sugar out of of them, and retain the pulp for feed. Some wonderful results are being shown in this country now as to the value of pulp for feeding lambs, fattening hogs and cattle, and feeding the dairy cow.

If the farmer would consider this proposition for a moment, he would see the economies that enter into it. Pulp can be secured at these factories for from 35 cents to $1 per ton. Of course it will not reach this latter figure until the stock interests begin to appreciate the value of the pulp for feeding. But where is it that a farmer can buy a ton of really nutritious stock food for a dollar? And the farmer's time is worth something to him. He should so arrange his work that he can accomplish the most with the least effort and the least loss of time. He should arrange it so that he can take a load of beets to the factory and then return with a load of pulp. This pulp is easily stored and easily taken care of. It can be kept for three or four years, if desired, without losing its qualities as a desirable and nutritious food. I am of the opinion that the farmers of this country should awake to their interest in this pulp question. The pulp should belong to the farmer just the same as the skim milk belongs to the farmer after he has sold the butter fat to the creameries, it being the common rule that farmers are to have the skim milk for stock-feeding purposes after the butter has been extracted. The same rule should apply to the sugar beet. The pulp should be the farmer's. He should be allowed to take away so many pounds of pulp for so many pounds of beets delivered. The factory people should regulate their affairs and prices purely upon the value of the sugar in the beet. The farmer is a great deal more capable of dealing with the pulp proposition. This rule would place things where they naturally belong.

If the farmers of this country, especially in the dairy business, would consider the immense value to them of having factories established in their localities to furnish them valuable food for their cows, three things would be settled:

First. That the farmers of this country could furnish butter for Europe and in competition with it. There would be no longer any doubt on this point.

Second. That this beet-sugar industry would succeed as a whole. There would be no further controversy over this.

Third. That this country would be safe in going ahead with the industry in the face of the possible results to the sugar interests by the annexation of new territory. There would be no further hesitation on that question.

Our superior advantages, facilities, and conditions and combinations of resources will offset the favorable conditions and cheap labor of Cuba for producing cane. The well-known tact, mechanical genius, and superiority of our artisans and laborers must be remembered as a balance in our favor. At the same time it must be remembered that pulp feeding is a real tangible fact that can be accurately measured and demonstrated.

I take from The Sugar Beet the following report of German experiments:

> Sixty pounds of forage beets may be replaced by 10 pounds of dried cossette residuum, with a daily increase of 2 pounds in the milk production. (This is based on the weight of the cattle fed at 1,200 pounds.) On the other hand, for 92 pounds per diem of forage beets was substituted 92 pounds of semifermented beet pulp. The daily milk increase was 3.8 pounds.

Here is another from The Sugar Beet:

> At the National Convention held in Belgium it was pointed out that 150,000 acres cultivated in beets yielded 2,098,000 tons of beets, which were sold for $9,450,000. The value of the resulting pulp was $1,250,000 and was sufficient to feed 800,000 head of cattle.

Parties from Montana have been investigating the pulp output of New York and are considering the matter of bringing 50,000 head of sheep and lambs East and fattening them on this pulp, having in view the fact that they will be nearer the ready market when the feeding is completed.

At Lehi, Utah, a large dairy owned by independent capital is run in connection with the factory. They are also feeding over 700 head of cattle.

At Eddy, as has been mentioned, the factory is fattening 1,100 head of lambs, which made a gain of 10 pounds each in twenty-one days. They propose to prepare these lambs for the market entirely on a ration of alfalfa and pulp.

In last year's report I called attention to an article by Mr. John Reimers, Grand Island, Nebr., an extensive feeder of stock, who gave a carefully detailed account of the results of his experiments with the feeding and fattening of stock for several years. There was a time when the Pacific slope used to call upon the Mississippi Valley for her butter, and upon the Eastern States and New England for her cheese, but since the introduction of the beet-sugar industry, California has rapidly forged to the front as a dairy State. A large part of this change has been brought about by the introduction of beet pulp as a food for the dairy. One of the most interesting examples of this fact will be found at Watsonville, Cal. Dairies have sprung up in all directions in that vicinity. Milk trains are running to San Francisco, and the dairy interests in this vicinity are almost wholly the result of the advantages of pulp feeding. Some of the factories in the West have had some trouble in convincing the farmers of the value of this pulp for food, but not so in New York. It happens that the creameries there preceded the sugar factories and have been studying for years the advantages of feeding by-products.

Breweries and distilleries have been sources of food for the dairy cows, but in certain instances where the purest of milk is required, as in certain hospitals, milk from cows fed on such refuse materials has been ruled out; yet the same authority has allowed the use of milk made from beet pulp, in fact claimed that it is really superior. In a short time there will be a contest as to who will get the pulp from the two factories there, but as New York has extensive general conditions for growing good beets at a profit, other factories are bound to start up in the State. I predict that the feeding industry, the dairy industry, and the beet-sugar industry will go hand in hand in that State in increasing its already wonderful resources as a commonwealth.

USES OF BEET LEAVES.

I notice that there is a good deal said in the press in regard to the value of beet leaves for feed, and that they are more or less fed to stock of different kinds in sections where farmers grow beets for factories. I hardly need dwell on the value of beet leaves for food. All who have had any experience with them will readily concede their nutritive value. If free from dirt, they would be an available addition to the list of silo plants; yet I can not help feeling that the ones who have given this subject most attention are right when they assert that these leaves are more valuable left on the ground in the fields as a fertilizer, inasmuch as they contain exactly the right elements that the soil needs, and in available form. It is all very well to assert that they can be taken back after being fed in the form of barn-yard manure. The trouble is that they are not likely to go back where they are needed—that is, where they came from. You must not be too greedy in "robbing" the beehive; something must be left to feed the workers during their period of inactivity. The same is true with the soil; we must keep it up to the standard even if we leave a little of the product which might be valuable in some other direction. Speaking to the point in question, we should leave the beet leaves on the ground as a fertilizer and feed the pulp.

PRODUCTION OF SUGAR-BEET SEED.

Among the facts gathered with reference to the beet-sugar industry for the present season were interesting data showing that our people, especially the manufacturers themselves, are grappling with the problem of producing their own seed, and good results are shown already. It is estimated that we import annually about 40 carloads of seed now, or about 1,000,000 pounds. There is no doubt about the necessity of our country working up as rapidly as possible in this business, because we are at an enormous expense in importing this seed from Europe; also because we are in more or less jeopardy in being dependent upon foreign countries for our seed. It has been seriously advocated at a convention held by parties interested in the beet-sugar industry in other countries that those countries should combine in an agreement not to furnish this country seed, in view of the rapid development of sugar manufacturing here. While such a policy does not seem likely to be adopted, yet it would be a serious matter for us should it occur. A disturbance of our trade relations with other countries is always possible, and on short notice. Millions of capital are already invested in implements of culture and factories, and a failure to secure seed for one year from Europe would be disastrous. There is too much at stake to depend on this source of supply. A third reason is that there is always danger in buying this European seed of being imposed upon in two ways: First, in securing seed of inferior quality as regards the production of beets of good sugar content, and second, in securing seeds, a large number of which will not germinate at all, which jeopardizes the stand of the crop when sown.

There is one thing that the sugar-beet growers and factory people of this country should insist upon, and that is an absolute knowledge of the quality of these imported seed. Every lot of seed that is sown to raise sugar beets for factory purposes should have a record based on a thorough test by somebody that they are of good quality. I have heard of one factory in this country—a recent experience—that furnished the farmers seed which were of a very low quality simply because said factory was imposed upon. Over half of the seed planted that year were of this kind. The results were very discouraging both to the factory and to the farmer. The test for the power of the seed to germinate is very easily made and can be performed by almost anybody after a little experience. All the countries of Europe have a standard upon which these tests of germination are based. For instance, there should be so many sprouts in so many days from so many seeds or so many pounds; a larger number of sprouts is required for small seeds than for large seeds. These standards take into consideration the germination after six days. For instance, in Prague at least 88 sprouts per 100 seeds are required; in Magdeburg, 46,000 per kilo. At Prague it is demanded that there be at least 70 sprouts out of 100 seeds in six days. This requirement is considered severe. The Sugar Beet says:

> The principal authorities agree that no attention should be paid to the size of the seed, which is the outcome of many climatic, soil, and other conditions, and does not influence the quality of the resulting beet. A fact difficult to explain is that large beets when taken for mothers give smaller seeds than do small mothers. It is proposed that a certain reform be made, based on the following principles: One kilo of beet seed should give a determined number of sprouts in six days; in fourteen days a determined number of seed should have germinated and given a determined number of sprouts, these numbers to vary with the number of seeds per kilo.

Among the places that have been active in working up the sugar-beet-seed industry are the factories at Lehi, Utah; Watsonville, Cal., and Eddy, N. Mex. The feeling seems to prevail generally that beet seed can easily be, and should be, grown in this country. This is a spirit not to be condemned, but when it is understood that the growing of sugar-beet seed is one of the most intricate features of the whole enterprise, requiring a large investment of capital and the application of considerable scientific knowledge, it will be readily seen that some years must pass before the United States will have fully established a safe and reputable sugar-beet-seed production. These seeds are not produced in the same manner as ordinary garden seed, such as cabbage, turnip, lettuce, etc., simply by planting out the beets and harvesting the seeds at the end of the year. They are produced in a series of plantings, and, according to the best information, it takes five years to realize a crop of sugar-beet seed after the series has begun. The series is required in order to produce seed of a high grade and sure quality, and it is the result of testing and selection. The sugar content and quality of the beet is kept up by the constant testing and selecting, and this is a matter of vital importance. The sugar beet, as such, is of too recent origin to have its habits of sugar producing so thoroughly fixed that we can depend upon it. These qualities we must be absolutely sure of, as they lie at the foundation of success in the sugar-beet enterprise. Under these circumstances we must depend upon the old-established and thoroughly equipped firms of Europe to produce our sugar-beet seed until such time as we can gradually and safely raise our own seed. There are undoubtedly firms in Europe which will, whenever they can, impose a poor quality of seed upon the American or any other purchaser. It becomes a matter of the greatest importance to the people in this country to be sure of the character of the firm from which they intend to purchase sugar-beet seed. Buyers should surround themselves with all possible safeguards in these transactions. In the first place they should understand thoroughly the responsibility of the firm, and in the next place they should buy seeds in original packages when they purchase abroad, and should demand an official certificate showing a test of their quality, germinating power, etc.

When these seeds are intended to be used in quantities they should be thoroughly tested as to their germination upon arrival. Seeds can be imported wholesale into this country for about 9 cents per pound. I understand that they have been bought recently for something less than that. When we shall be able to safely produce our own seed, it will undoubtedly be to our advantage, as the tendency will be to build up, establish, and perpetuate the sugar-producing habits of the plant under our own climatic conditions.

PROSPECTS FOR NEW FACTORIES.

The following notes are the accumulation of items gathered during the past year in various ways, through correspondence, personal observation, conversation with leading agriculturists and others, and newspaper clippings. They tend to show the intense interest of the people in this subject, at the same time the diversity of territory inhabited by those interested, and the progress the industry is making in the United States.

CALIFORNIA.

C. F. Heintz, editor of Rural California, Los Angeles, has sent at his own expense a lot of seeds to Arizona and California, and wants a lot more seed for distribution.

The Union Beet Sugar Company has decided to build a factory at Arroyo Grande or Los Berros, and negotiations are being made for its erection.

A beet-sugar company has been organized at Clovis. Fresno has a prospect of a factory.

The San Francisco Chronicle says:

> The syndicate which has been negotiating for a beet-sugar factory in Sacramento Valley has secured 150,000 acres and will erect three immense factories. Its capital is $15,000,000.

The San Francisco Call says:

> The English company, with $15,000,000 capital, has commenced the work of erecting three factories in Sacramento Valley, which will be completed during the next year. Notice has been filed that the board of directors of the California Beet Sugar Refining Company has decided to issue $1,000,000 in bonds.

COLORADO.

Ex-Governor Eaton, of Eaton, has 16,000 acres of land, and is much interested in sugar beets.

At Greeley the people have organized a company and are pushing the subject of establishing a factory.

The Arkansas Valley people of Colorado are pushing the subject of beet sugar, and it is thought that they have a chance through irrigation to make a success of the industry.

In Colorado Springs the editor of a paper who is interested in the sugar-beet question has given it considerable attention; a great many beets have been grown and a good showing made.

The Western Colorado Beet Sugar Association, president, S. D. Delan, Glenwood Springs; secretary, C. E. Mitchell, Grand Junction; treasurer, H. J. Holmes, Glenwood Springs; have experimented extensively with raising sugar beets, and have given me a full report of the results attained. Extensive experiments are being made in Mesa, Delta, Chaffee, and Weld counties, Arkansas Valley, San Juan Valley, the Greeley district, and at Fort Collins and Glenwood Springs.

They are holding meetings at Grand Junction, and much enthusiasm has been aroused. Two men are scouring the county to interest people in a factory. I think they will secure it. One thousand two hundred acres are already offered for planting beets. It is rumored that a trust is trying to purchase 1,200 acres in the eastern rain belt to raise sugar beets. The Denver Chamber of Commerce has determined to make the beet-sugar industry a feature of that State and is advocating the employment of convict labor.

The Denver Times says:

> The necessary bonus for beet-sugar factory at Grand Junction is secured. Work upon the building will be started shortly. Farmers have agreed to raise sufficient beets. Colorado wants a bounty of one-fourth cent per pound.

Fort Collins, Greeley, and Loveland shipped a train load of beets to Grand Island, Nebr. They all expect factories. Fort Morgan seems to have a favorable prospect for a factory. The same is true of Burlington and Loveland.

The Denver Chamber of Commerce decided to offer $2,000 in prizes, and to this amount the various railroad companies added $4,000. Mesa, Delta, Chaffee, and Weld counties are entering into the contest. Glenwood Springs and Grand Junction are taking hold of the factory proposition. The farmers of Arkansas and San Juan valleys are meeting with success in their efforts to get a factory.

IDAHO.

American Falls, Oneida, Lewiston, Lapwai, and Nezperce are recommended as suitable places for factories.

A party owning 1,200 acres of land who has been visiting various factories in the United States and Germany claims that a Chicago firm will put in a factory at Idaho Falls.

At a largely attended meeting the farmers of Franklin decided to build a beet-sugar factory on the cooperative plan.

At Leland parties claim a valley 20 by 30 miles, very productive, and call for beet seed to experiment with. The farmers will organize. J. W. Spartinger is in charge.

ILLINOIS.

At Makanda George C. Hanford is very much enthused over the beet industry; sends for 100 pounds of seed to test several counties in southern Illinois.

Mr. Davis, Chicago, industrial agent of the Santa Fe Railroad, has managed extensive experiments in different parts of the country on this system, especially in the arid region. He is very much interested in the sugar-beet industry for New Mexico, Colorado, and California.

Active interest in organizing at Quincy, Decatur, Springfield, Peoria, Galesburg, and Ottawa is reported. The Illinois Sugar Beet Association is running experiment stations at the above towns and expects to establish a factory at each of those places in the near future. There is a probability that a half dozen factories will be built in the State, costing $350,000 each.

Chicago capitalists are willing to furnish $200,000 if Springfield will furnish a like amount. Springfield Business Men's Association is discussing a factory.

Chicago capitalists are willing to back Peoria with $200,000 if Peoria will put in $200,000. Articles of incorporation for a beet-sugar factory have been filed with the secretary of state for the Peoria factory, capital stock $250,000.

Meetings to discuss the sugar-beet industry still continue to be held at Quincy, Decatur, Springfield, Peoria, Galesburg, and Ottawa. People at Galesburg are active in the proposition to establish a factory.

The Moline Plow Company, Moline, Ill., has out a complete line of agricultural implements along the line of the sugar-beet industry which they have improved from time to time. They are keeping abreast of the industry as it develops.

INDIANA.

Hamilton County is being thoroughly tested, with a probability of a factory.

The Commercial Club and Board of Trade of Indianapolis have taken steps to secure the location in their city of a plant for the manufacture of beet sugar. The State board of commerce has been induced to promote the project and encourage the construction of a beet-sugar factory at Indianapolis. There is talk of Shelby, Rush, Decatur, Bartholomew, and Johnson counties joining to project and build a factory at Shelbyville. It is claimed that English capitalists will build a factory at Fort Wayne. Most of the arrangements have been completed. There will probably be a factory built at Sellersburg, Clark County.

The Commercial Club and Board of Trade of Indianapolis are looking out for a factory at that place, and have arranged for railroad rates for beet shipments, as follows:

	Per ton.
To 30 miles	$0.50
30 to 50 miles	.65
50 to 75 miles	.75
75 to 100 miles	.85

The farmers will ask for a bounty. It seems likely that Fort Wayne will have a beet-sugar factory of 350 tons. Farmers have pledged 2,000 acres of beets. Local capitalists have raised $200,000.

In the Kankakee Valley, at North Judson, the people have experimented extensively in the sugar-beet culture and held a convention attended by 2,000 people. An address was delivered by Judge Buman Knox, who has given the subject a great deal of attention. Professor Huston, of Purdue University, Lafayette, is alive in this line, and addressed the meeting. Governor Mount also addressed the convention.

IOWA.

At Des Moines a committee consisting of John S. Emery, Frank D. Jackson, and Robert Fullerton are stimulating the interest in beet sugar in the State. These people hope to encourage the location of several factories within the State.

Jefferson has made a good showing and is working to capitalize a company.

At Muscatine Mr. Kemble has this matter in charge and hopes to work up an interest. They have experimented extensively at this place, growing a good, high-quality beet. This would be a good location for an Iowa factory.

At Waterloo, Cedar Falls, Mason City, Des Moines, Ames, and Cedar Rapids agitation continues. Fort Dodge wants a factory. Some fifty persons have taken up the question of beet sugar at Marshalltown. Citizens of Waukon have subscribed $200,000, so it is said.

Davenport is arranging to establish a factory. The question of a factory is being agitated at Keokuk, Indianola, Waterloo, and Cedar Rapids.

Mason City and Clear Lake carried on thorough experiments in their respective sections during the past year. It is one of the best adapted places in the State for growing a good beet and locating a factory.

MARYLAND.

The farmers are seriously discussing a factory at Williamsport with small stations within a radius outside. The Williamsport Board of Trade contemplates a factory at that place. (This idea of small stations will probably be abandoned when investigated.)

MICHIGAN.

At Orion, James Y. Clark, secretary of grange, claims they are ready. The farmers will push a factory.

At Alpena, Alpena County, Mayor Gilchrist, a large capitalist, offers to put up a large factory if the farmers will take hold, test the beet problem, and grow the beets.

The plan for a factory at Essexville has been completed and work will be pushed in 1899. Efforts are being made to establish factories at the following places: Battle Creek, Muskegon, and Grand Rapids.

A party has left for Germany to inspect beet-sugar plants with the expectation of erecting a plant at Detroit with $1,000,000 capital.

A beet-sugar factory at Benton Harbor is assured as soon as 3,500 acres of beets are pledged. A $350,000 factory will be erected.

Grand Rapids is striving for a factory. It is expected that a 500-ton factory will be built at Saginaw.

A company to manufacture beet sugar was organized in Wayne County last year. One member of the company has been in Germany during the year studying the industry. Benton Harbor and Saginaw are anxiously awaiting the result at Essexville with a view to establishing factories. At Benton Harbor 2,500 acres have been pledged by farmers, and a site has been selected and money raised to erect a $350,000 factory. The factory contemplated at Benton Harbor will be a 350-ton plant. West Bay City is determined to have a factory. For some time past the matter of establishing a factory at Battle Creek has been agitated.

The Port Huron Beet-Sugar Company claim they have had most promising results in sugar-beet cultivation and they are still holding the farmers to pledge sufficient land to run a factory.

MINNESOTA.

Tax Commissioner P. M. Clarke, Chicago and Great Western Railroad, St. Paul, Minn., claims that on their road, 30 miles south of the city, is a fine location for a factory, and the road will experiment among the farmers extensively in raising sugar beets.

Industrial Agent W. J. Reed, 604 Endicott Building, St. Paul, Chicago and Great Western Railroad, states his desire to cooperate in southern Minnesota, Iowa, and Missouri. This same officer has taken this subject up in other places.

Kellogg, Minn., wanted considerable seed in order to test the sugar-beet question.

At Stockton, Winona County, the people have organized the American Sugar Growers' Society and have four branches. Benjamin Sherry is secretary of Stockton branch.

The Chicago and Great Western Railroad, through P. M. Clarke, St. Paul, Minn., has interested itself in experiments in Rich, Vermilion, Cannon River, and Prairie Creek valleys.

G. Seebach, Austin, Minn., says the farmers have experimented extensively and want a factory. I visited this place, and there are many things that make it desirable. I think the soil and climate adapted and other conditions are fair.

Albert Lea has grown a lot of sugar beets and will sell them to the Minneapolis factory. This is arousing interest in the factory question. There is a large Danish and German element at Albert Lea, and conditions are all good for establishing a factory. Harry Jones, First National Bank, and W. A. Morin are the parties in charge. Last year they collected $600 and raised 100 plats of beets under a competent superintendent or expert sugar-beet raiser. Their experiment was a thorough test of the county.

MISSOURI.

It is reported that the German-American Colony Association has purchased 10,000 acres in Clark County and will build a beet-sugar factory.

On the lands of the Missouri, Kansas and Texas Railroad the company and others have made extensive experiments with sugar beets from Missouri to Texas. Prof. H. H. Nicholson, chemist at Lincoln, Nebr., made the analyses. D. J. Spricht, Whitesboro, Tex., is the secretary and the one in charge of this work.

MONTANA.

W. A. Clarke, of Butte, Mont., is thinking very strongly of putting a factory in Montana. Henry Allenbrand, of Brooklyn, N. Y., is also contemplating a factory in Montana.

NEBRASKA.

G. R. Williams, president; W. N. Mason, secretary, both of Omaha, have organized a company to manufacture beet sugar, and propose to manufacture glucose and starch after the beet-sugar campaign closes.

The board of trade at Fremont is trying to arrange for a 750-ton factory.

W. N. Mason, secretary of the sugar-beet company organized at Omaha, calls for a large amount of seed to try the land where the factory will be built.

I. R. Alter, Grand Island, Nebr., has experimented extensively with feeding pulp at Grand Island, Nebr., and is posted on its value as food.

NEW JERSEY.

Trenton is thinking of a 700-ton factory. The State bounty was vetoed by the governor.

NEW MEXICO.

At Albuquerque a good showing has been made in the way of sugar-beet experiments. Men prominent in this work are A. Grant and J. D. Baraclough.

Santa Fe has experimented extensively in the sugar-beet industry and first-class results have been obtained from this locality. The people are enterprising and working to establish a factory. Capt. S. H. Day is prominent in this work.

At Roswell, Colonel Elliott experimented successfully. This is a very fine fruit country, especially for apples. They raise very fine beets for the Pecos Valley factory. Their irrigation is from a system of artesian springs.

Extensive experiments were carried on near Santa Fe. They intend to put a factory in next year.

A factory will be built at Albuquerque if the farmers will pledge 10,000 acres for beet cultivation. The prospect rests wholly with them; the only thing now required is that sufficient acreage be pledged for five years.

NEW YORK.

Carthage has a prospect for a factory in the near future. Beets were raised this year and sent to Rome. The idea of penitentiary labor for raising sugar beets is being agitated, as this solves the labor problem by avoiding conflict with labor organizations. It is reported that German capitalists propose putting up a $300,000 factory with a capacity of 1,000 tons at some convenient point, and Lyons is trying to secure it.* There is strong talk of a factory at Redwood, Jefferson County; farmers agree to plant 4,000 acres for five years.

Buffalo Beet Sugar Company, capital $600,000, is organized and proposes to build a factory at Irving. Chautauqua Company has contracts made with 500 farmers for 3,000 acres. Lockport wants a factory. The people are giving serious consideration to the subject of a factory at Syracuse. At Penn Yan, Ed C. Wilkins is working for an organization and thinks they will have a factory. He is experimenting extensively in order to educate the farmers.

OHIO.

There is talk of an immense factory at Sandusky. There is also talk of a $50,000 bounty to be distributed among manufacturers in Ohio. The legislature failed to pass the bounty act, which puts the question off for two years. The board of trade at Springfield is trying to interest farmers locally in the sugar-beet business.

The secretary of Lake Erie Beet Sugar Company has been in Germany for some time, and has secured $500,000 German capital. Contracts for 2,000 acres of beets have been secured and 1,000 more are desired. The Toledo Beet Sugar Company has been active in developing the industry for that city.

The Erie County Sugar Beet Association is making some favorable offers to secure a factory. It is claimed there will be factories at Erie, Ottawa, Sandusky, and Huron. The factory at Toledo will be located on the canal between the Wabash and Clover Leaf railroads. It is thought it will be ready for business next fall with a capacity of 750 tons per diem.

The Lake Erie Beet Sugar Company, of Sandusky, is desirous of entering into a five years' contract with farmers to grow a certain number of acres of beets, for which they agree to pay $4 per ton. Bowling Green is enjoying at least a prospective boom for a factory.

OREGON.

Medford and vicinity grew sugar beets of a very fine quality. Mr. Spreckles is in communication with them to build a factory. This is in the extreme southwestern part of Oregon, and undoubtedly will hold out strong inducements for those interested in this industry.

PENNSYLVANIA.

They think a factory is assured for Erie, also for Bradford. Reading claims to be a center where a factory will be built.

Local capitalists of Pittsburg are talking strongly of establishing a factory.

There is a project on foot to establish a factory opposite Harrisburg.

It is stated in Carlisle that the beet-sugar factory enterprise has been a success, and that between 400 and 500 farmers have signed contracts. In the vicinity of Carlisle there is every prospect of a factory.

SOUTH DAKOTA.

In South Dakota there is talk of erecting a factory at Sturgis. The agricultural college established experimental tracts for growing sugar beets at Sioux Falls, Aberdeen, Huron, and Yankton. All these places are striving for factories. It looks strongly probable that Sioux Falls will get a $350,000 plant.

At Yankton the beet-sugar question has been discussed; a $285,000 factory is expected. The question of a factory in the Black Hills, on Spear Fish River, is being agitated. There is natural water power.

Sioux Falls has organized a company and shown activity in stimulating the beet-sugar enterprise.

Aberdeen is a lively place, and has taken a very active interest in the beet-sugar industry. They came very near locating a factory at one time, and are still energetic in this direction. The local worker is S. W. Naragang, of this place. Prof. J. H. Shepard, of Brookings, is the active promoter of the sugar-beet industry in the State.

TEXAS.

The people at Barstow claim that the Oxnard Construction Company is considering the proposition of putting up a factory there.

UTAH.

St. George is negotiating for a beet-sugar factory. The Mount Nebo Beet Sugar and Land Company will erect a 500-ton plant next year.

VIRGINIA.

The question of establishing factories at Norfolk, Newport News, and Roanoke is being considered. Richmond is seriously considering the question.

WASHINGTON.

At Spokane they have organized a company backed by the railroad, and have made a very fine showing and will probably put in a factory.

The chances seem good for establishing a factory at Walla Walla. A mass meeting was held there, and an offer was made to erect a factory of 1,000 tons, provided a bonus of $100,000 was raised. The Walla Walla Commercial Club thinks the $100,000 bonus demanded can easily be raised. A Salt Lake company offers to put in a million-dollar factory, and demands that after twenty or thirty days' trial a bonus of $100,000 shall be paid. The bonus can be paid in beets.

Scott's company proposes to erect a factory at Waverly.

WISCONSIN.

At Kilbourn, L. Stowe, jr., is taking great interest among the farmers in testing the sugar-beet industry.

There is a strong probability of a factory at Merrillan; also a 500-ton factory at Greenbay. At Merrillan a factory was to have been built of 400 tons capacity. Two thousand five hundred acres of land were offered as a bonus. This is now offered for sale, but will be withdrawn if somebody will accept it as a bonus and build the factory.

The Northwestern Beet Sugar Company has filed a trust deed, given by it to the American Savings Trust Bank, Chicago, covering 35,000 acres of land in Clark County.

EXPERIMENTS IN GROWING SUGAR BEETS IN 1898.

The following is a brief review of the work done in the various States during the past year, summarizing results and status of sugar-beet growing, as represented by officers of the various State experiment stations:

ARIZONA.

Prof. C. S. Parsons, director.

Arizona changed its method of experimenting this year, and experiments were carried on under a much improved plan. Ten plats were selected, varying from one-half to an acre in size. The farmers gave the land; the station did the work and furnished all machinery. The results were:

Average sugar content	per cent	13.8
Average purity coefficient	do	78.5
Average tonnage of beets per acre		12.9
Sugar yield per acre	pounds	2,470

These 10 plats were all raised near Phœnix, in Salt River Valley.

Arizona offers no bounty on home manufacture of sugar.

IDAHO.

Dr. C. W. McCurdy, professor of chemistry, in charge of beet culture.

Nampa, Canyon County; Blackfoot or Idaho Falls, Bingham County; and Latah County, located in Clearwater Valley, are suggested as the best localities for manufacturing sugar and growing sugar beets. Farmers report average yield per acre, 15 tons; average cost per acre, $20.

In 1897 the combined results of four years' work and the average of 635 analyses gave 14.56 per cent in sugar, with a purity coefficient of 84, and with a maximum of 21.9 per cent in sugar.

The State at present offers no bounty on domestic sugar.

ILLINOIS.

Prof. E. Davenport, director, under whose direction sugar beets are grown. Report is made by Prof. P. G. Holden, his assistant.

Out of 1,200 pounds of seed furnished to the different communities, each had agreed to grow at least 4 quarter-acre patches. Five places—Decatur, Springfield, Quincy, Galesburg, and Peoria—organized and raised a fund of $500 each, and engaged the services of an expert to look after the work. Four other places—Ottawa, Kankakee, Mattoon, and Rock Island—organized and carried out the work under the direction of the experiment station. Nine or 10 acres of beets were grown by each of the nine communities. Fifteen other communities grew 4 quarter-acre patches each. Experiments seem to show that the northern two-thirds of the State is best adapted for growing sugar beets. The cost of growing beets in the fields under the management of an expert varied from $28 to $36 per acre. This included subsoiling and rent of land, the latter varying from $5 to $10 per acre. The yield varied from 12 to 26 tons per acre of topped beets ready for factory.

Where the beets were grown under the direction of this expert, factory methods were used, and lectures with illustrations given at stated periods. Five and one-half acres were grown at the station, the average cost, including rent, being $35.90 per acre. The yield of topped beets on clover sod was 23.65 tons per acre. The yield of topped beets on corn stubble was 18.65 tons per acre.

Peoria and Pekin have combined and begun the erection of a 700-ton factory at Pekin under the corporation name of The Illinois Sugar-Refining Company of Peoria. The business men's association pushed through this sugar-beet growing enterprise at the various places, aided by the farmers' institutes.

The State offers no bounty for the production of domestic sugar, but the same is being agitated in the present legislature.

INDIANA.

Prof. C. S. Plumb, director, under whose direction the experiments in sugar beets are conducted.

Experiments seem to indicate that the best section for growing sugar beets is in the northern part of the State. Very favorable reports are made from Allen, Jaspar, Starke, and Pulaski counties. Experiments indicate that from 12 to 13 tons per acre of beets can be raised. At present the State pays no bounty on the manufacture of domestic sugar.

IOWA.

Prof. C. F. Curtiss, director, under whose supervision sugar beets are grown.

The system of experimentation in the State was modified from that of general distribution of seeds to that of stimulating localities to organize and grow beets on fewer and larger plats in a more systematic manner. Among the places participating and which have taken an active interest for some years were Dubuque, Hedrick, Jefferson, Cedar Falls, Waterloo, Mason City, Muscatine, and Burlington. On the experiment-station ground beets were raised on 20 plats, experiments including different methods of cultivation, thinning different distances in the row, planting the rows at various widths, and application of salt and lime and different qualities of farmyard manure. Samples were taken for analyses at five different periods, and the results are shown below. The samples of each date averaged as follows:

Date.	Sugar.	Purity.
	Per cent.	*Per cent.*
October 15	12.50	81.80
October 22	12.23	81.21
October 29	12.88	84.89
November 4	13.94	85.93
November 17	12.29	77.38

It will be observed that samples taken November 17 were inferior in quality to those taken on previous dates. As the same care was taken in harvesting at each period, it can be accounted for by the fact that heavy rains previous to this date caused a new growth, and this affected the purity and sugar content.

Best results were obtained from beets in rows, planted 20 inches apart, the order of preference in width apart of rows being 20, 16, 24, and 28 inches.

MICHIGAN.

Prof. Clinton D. Smith, director, under whose supervision sugar beets are grown.

Methods of experimentation in growing sugar beets were changed somewhat this year, it being the endeavor to confine the experiments to larger plats under more careful supervision, having in view the idea of securing as accurate data as possible on the cost of raising sugar beets, which was found to be from $25 to $40 per acre.

The whole of the southern peninsula of Michigan is giving good results in growing sugar beets and has for several years past. The best have appeared to come from Manistee and Oakland counties and along the western border of the State. There is a strong probability of another factory being built at Bay City and one at West Bay City; also companies are organized and capital raised for building factories at Alma, Detroit, Rochester, and Benton Harbor. The following places are also endeavoring to organize the beet-sugar industry: Saginaw, Grand Rapids, Kalamazoo, and Port Huron.

The State offers a bounty of 1 cent per pound for all sugar made in the State, on condition that the factory pay the farmers $4 a ton for beets containing 12 per cent of sugar. A factory of 350 tons capacity was built and operated this year for the first time at Bay City.

MINNESOTA.

Prof. W. M. Liggett, director; beet-sugar work, under the direction of Prof. Harry Snyder, chemist.

The beets grown at the experiment station contained from 16 to 18 per cent sugar, with a purity coefficient of from 82 to 88.

About 2,800 acres of beets altogether were raised in this State this year. A factory of 300 tons daily capacity is in operation for the first time at St. Louis Park, near Minneapolis.

Out of 11,000 samples of beets tested by the chemist of the factory, the average sugar content was 14.04 per cent, with an average purity coefficient of 83.

The station has been making analyses of various limestones throughout the State and has located at least five quarries where high-grade limestone may be obtained, suitable for beet-sugar processes. The average sugar content, as shown by the chemist of the factory at St. Louis Park, which is 14.04 per cent, agrees very closely with the average at the station, which for the past ten years has been 14.22 per cent. This demonstrates the reliability of station forecasts based on scientific and experimental data.

The average cost for growing sugar beets in the State is from $30 to $35. The average tonnage per acre is 14 to 18 tons.

Every arrangement is being made to construct a factory at Winthrop, it is stated, having a capacity of 350 tons.

The State pays a bounty of 1 cent per pound on all high-grade refined sugar produced within its borders.

MISSOURI.

Prof. H. J. Waters, director, under whose supervision the sugar beets are grown.

Sugar-beet seed was distributed to about 1,200 farmers this year, and results have not yet been tabulated. The localities showing the best indications for growing sugar beets are in the northwestern corner of the State, comprising the counties of Schuyler, Scotland, Clark, Lewis, Knox, and Adair.

No bounty is paid by the State at present for the production of domestic sugar.

MONTANA.

Prof. S. M. Emery, director, under whose direction sugar beets are grown.

Considerable interest is being developed in this State.

The following are the averages from beets sent in from outside ranches:

Average weight	ounces	29
Average sugar in the beet	per cent	17.66
Average purity coefficient		82.9

Results of beets grown on the experimental farm:

Average weight	ounces	21.4
Average sugar in the beet	per cent	13.62
Average purity coefficient		78.32

NEBRASKA.

Dr. George E. MacLean, director; beet-sugar experiments under direction of Professor of Chemistry H. H. Nicholson.

The sections of this State producing the best beets are in the northeastern and west central districts.

Experiments have shown that the cost of producing beets is about $30. The average tonnage per acre is 11 to 12.

There are two factories in the State, located at the following places: Grand Island and Norfolk; each has a capacity of about 300 tons.

There is no bounty paid by the State at the present on domestic sugar.

NEVADA.

Prof. J. E. Stubbs, director.

On account of lack of snow last winter, and the consequent dry season, the farmers were not able to grow beets successfully.

The western section of the State shows, perhaps, the best conditions for producing sugar beets of good quality.

Quite a number of samples were analyzed, sugar in the beet being 16 per cent, with an average coefficient of purity of 85.

This State at present offers no bounty for the production of domestic sugar.

NEW MEXICO.

Beet-sugar experiments under the direction of Prof. Arthur Goss, professor of chemistry.

The seeds were sent to fewer persons this year, the list comprising those who did the best work last year. Beets were also grown at the station. The sugar content all over the several sections of the territory was remarkably high. The indications are that the northern part of the State is best adapted for growing sugar beets, especially in the Animas Valley, in San Juan County, and around Santa Fe, in Mora County. Good reports also come from Taos and Chaves counties.

This State already has a factory at Eddy, in the Pecos Valley. This naturally gives stimulus to the enterprise in establishing this industry in other parts of the State, notably at Santa Fe and Roswell.

New Mexico pays no bounty at present on the production of domestic sugar, but the capital invested in the industry is not taxed.

NEW YORK.

Geneva station; Prof. W. H. Jordan, director.

This station has conducted experiments in sugar-beet raising in eleven counties. In one or two places in each county half-acre plats were planted. Besides this, small lots of seed were distributed to quite a number of farmers. Data is not yet complete as to the results. Factories have been built and operated during the past year as follows: At Rome, a factory having a capacity of 200 tons; at Binghamton, a factory of 300 tons.

There is a strong probability of factories at the following places: Penn Yan and Dunkirk. This State is at present paying a bounty to the manufacturer of 1 cent per pound. This is paid on the condition that the farmers shall receive $5 per ton for the beets. Before this bounty was secured the manufacturers proposed to pay $4 per ton, and if the bounty were removed the prices would probably return to that figure.

NORTH DAKOTA.

Prof. J. H. Worst, director; experiments under the direction of Prof. E. F. Ladd, chemist.

Sixteen samples were received from the State, with the following results:

Maximum per cent of sugar	20.20
Minimum per cent of sugar	9.92
Average per cent of sugar	14.38
Coefficient of purity	79.4

Yield of beets per acre, 7 to 18 tons.

The two southern tiers of counties east of the Missouri River are best suited for the sugar-beet industry.

The cost per acre for raising sugar beets ranges between $20 and $25.

This State at the present offers no bounty on the manufacture of domestic sugar.

OHIO.

Sugar-beet work under Professor of Chemistry A. D. Selby.

Seed was sent out quite generally over the State. The results have not yet been compiled. The section of the State showing the best conditions for growing the sugar beet is the northern part, especially near the lake shore. The districts around Springfield have also given good results.

The average yield of beets, as shown by experiments, is about 10 to 12 tons per acre. There is a strong probability of a factory at Sandusky, to be built by the Lake Erie Beet Sugar Company.

This State offers no bounty for the manufacture of domestic sugar.

OREGON.

All sugar experiments under the direction of Professor of Chemistry G. W. Shaw.

About 250 analyses have been made during the past year of beets grown in the State, with results as follows: Average per cent of sugar in the juice, 15.12; average purity coefficient, 85.

The places in the State indicating the best results and the best conditions for producing sugar beets are eastern and southern Oregon, particularly Union, Umatilla, and Malheur counties, in the eastern part of the State, and Jackson County, in the southern part.

Experiments indicate that the average cost of producing sugar beets is about $30 per acre, with an average yield of about 15 tons per acre under proper cultivation. A factory was built and equipped and started in operation this year at Lagrande, in Union County. There is strong probability of factories at Ontario, Malheur County, and at Medford, Jackson County.

At present the State of Oregon does not offer any bounty either on beets or sugar; but there is now pending before the legislature a bill for a bounty on beets, with a strong probability of passing.

SOUTH DAKOTA.

Dr. J. H. Shepard, professor of chemistry, in charge of the beet-sugar experiments.

Experiments have been conducted on a commercial scale at five points in the State; about 5 plats in each place have been cultivated, varying from one-fourth of an acre to an acre in area. The prime object is to ascertain the cost per acre of raising beets. The sections showing the best results are Big Sioux Valley, the James River Valley, and a section in the Black Hills. In the work this year the cost varied from $25 to $50; $30 is probably about the right figure. No proper tools or workmen acquainted with the work were available. The tonnage this year runs from 10 to 20 per acre. Strong efforts are being made to locate a factory at Sioux Falls. Data is not yet compiled as to results, but beets grown in South Dakota have always shown a very high sugar content and purity. Results from this State are among the best in the United States.

This State now offers a bounty of 1 cent per pound on all beet sugar manufactured in the State.

WASHINGTON.

Professor of Chemistry Elton Fulmer, in charge of the beet-sugar experiments.

No data is furnished as to the results of experiments this year, but the districts showing good results are Yakima, Kittitas, Lincoln, Spokane, Whitman, and Wallawalla counties. Experiments indicate that the cost of raising beets is about $30 per acre, and that from 18 to 20 tons per acre can be grown. Fairfield and Waverly, in Spokane County, and Walla Walla, in Wallawalla County, have shown good results in growing beets, and efforts are being made to establish factories at these places. The establishment of a factory at Walla Walla is quite probable.

This State now pays a bounty of 1 cent per pound on the manufacture of sugar; one-half cent goes to the beet grower and one-half cent to the manufacturer.

WISCONSIN.

Prof. W. A. Henry director; Prof. F. W. Woll, chemist of the station, in charge of beet-sugar experiments.

The experiments were carried on in this State this year in a more detailed way, and by farmers who had the most experience. The purposes of the experiments this year were three: First, variety tests; second, fertilizer tests, and, third, tests of sugar beets grown by Wisconsin farmers in different parts of the State with seeds sent out by the Department of Agriculture.

The average results of the tests were as follows:

Year.	Number of samples.	Sugar in juice.	Parity coefficient.	Yield per acre.
		Per cent.		*Tons.*
1897	1,663	12.67	74.1	12.8
1897 (substations)	98	14.35	80.4	14.9
1898	253	15.15	78.8	12

It is believed the average tonnage per acre for 1898 is more nearly the correct figure, since greater attention was given to secure accurate data.

ANALYSES OF SAMPLES AT STATE EXPERIMENT STATIONS.

The various experiment stations of the United States have been making some very careful experiments with beets grown in different parts of their respective States under special regulations prescribed by the stations. The following tables compiled by these stations show the results of chemical analyses of the beets produced and other interesting data.

The tables are mostly for the work of 1897, because that of 1898 is not yet compiled and published. In a few cases, however, advance sheets showing results for 1898 prior to publication at the stations have been sent and are included in the tables.

Some of the States in the sugar-beet section failed to send me bulletins of their work for either of these years, as requested, and therefore I am not able to furnish results in such States. The tables follow.

THE UNITED STATES, 1897.

Comparative analyses by States.

[Compiled by the Idaho Experiment Station.]

States.	Season.	Yield per acre.	Number of analyses averaged.	Sugar in juice.	Coefficient of purity.	Sugar content of sweetest single beets as analyzed by the stations.
		Tons.		*Per cent.*		*Per cent.*
Arizona	1897	15.0	41	11.90	73.6	17.70
Colorado	1897	16.0	51	15.50	81.6	23.00
Idaho	1897	15.0	41	15.17	87.55	21.90
Illinois	1897	12.5	314	12.70	78.70	17.50
Indiana	1897	18.0	307	12.90	80.60	22.90
Iowa	1897	22.0	653	13.70	77.40	[1] 17.40
Kansas	1897	....	180	11.98	78.40	....
Michigan	1897	15.0	465	16.40	84.00	22.30
Missouri	1897	15.0	304	11.14	71.00	21.02
Montana	1897	15.0	136	17.10	81.90	20.00
Nebraska (average, 5 years)	....	13.0	10,000	13.60	81.60	22.90
Nevada	1897	10.0	19	16.08	....	23.60
New York:						
Ithaca	1897	16.9	425	16.91	83.30	21.50
Geneva	1897	12.0	140	15.30	82.90	....
New Mexico	1897	16.0	274	14.46	78.00	22.5
Ohio	1897	10.0	607	14.00	79.7	20.00
Oregon	1897	18.5	206	15.24	84.26	23.90
South Dakota	1897	21.9	951	16.40	85.60	22.90
Utah	1897	17.2	299	14.24	83.10	23.00
Washington [2]	1897	18.0	521	17.96	81.3	26.60
Wyoming	1897	15.0	34	18.00	83.3	25.50

[1] Average of ten samples.

[2] The average of 10-acre plats.

ARIZONA, 1898.

Final results on sugar-beet plats near Phœnix, Ariz., 1898.

Location of plat.	Date of sowing.	Date of harvesting.	Number of beets per square rod.	Average weight of beets dug.	Yield per acre.	Sugar in beets.	Coefficient of purity.	Approximate yield of sugar per acre.
				Ounces.	*Tons.*	*Per cent.*		*Pounds.*
Grier ranch	Feb. 25	July 16	116	24	15¼	11.1	75.5	2,555
Murphy ranch	Feb. 24	July 22	161	11¾	9	15.7	82.1	2,210
Christy ranch	do	July 26	184	18	16¾	14.1	78.7	3,395
Canaigre ranch	Feb. 23	July 27	201	4¾	4¾	17.5	86.0	1,900
Canaigre ranch	do	do	182	15¼	13¾	13.7	77.1	2,705
Indian school	Feb. 21	July 28	186	20⅒	10¼	13.3	80.6	2,085
Fowler ranch	Jan. —	July 30	175	15	13⅒	15.1	78.4	2,655
Fowler ranch	Mar. 1	do	171	19	16¼	12.0	74.9	2,600
Hough ranch	Mar. 14	Aug. 2	168	17	14¼	12.3	77.4	2,525
Experiment-station farm	Feb. 26	Aug. 3	136	21¼	15½	13.0	77.2	2,785
Average			168	15.6	12.9	13.6	78.5	2,470

COLORADO, 1897.

EFFECT OF FREEZING ON BEETS.

When the beet fields on the college farm were harvested several small patches were left and allowed to freeze. After the tops had frozen and thawed several times, the whole was covered with a thick layer of straw. Samples of these beets were analyzed at various times up to the middle of January, 1898. From near the edge of the straw some beets were dug that had been partially frozen.

The first beet analyzed had been only slightly frozen. It was cut into thirds by weight and each third analyzed.

	Sugar.	Coefficient of purity.
	Per cent.	
Upper third	12.9	78.7
Middle third	12.0	91.1
Bottom third	12.0	81.4

The second beet had been decidedly frozen.

	Sugar.	Coefficient of purity.
	Per cent.	
Upper third, all frozen	10.9	73.2
Middle third, partly frozen	11.2	70.8
Bottom third, not frozen	14.3	88.3

Here the effect of the freezing seems to have been to drive the sugar into the lower part of the beet.

EFFECTS OF RIPENING.

In the ripening of sugar beets, there is not only an increase of sugar and consequently a relative decrease of the impurities, but there is also an absolute decrease of impurities. This is shown in the next to the last column of the following table, which is based on the results of about two hundred analyses of the Colorado beet crop of 1897.

Beets anging in per cent of sugar from—	Water.	Total solids.	Insoluble fiber.	Sugar.	Soluble impurities.	Coefficient of purity.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
8 to 11	81.0	19.0	5.0	9.9	4.1	70.2
11 to 12	79.7	20.3	5.0	11.6	3.7	76.0
12 to 13	78.8	21.2	5.0	12.5	3.7	77.0
13 to 14	77.9	22.1	5.0	13.5	3.6	78.8
14 to 15	77.1	22.9	5.0	14.4	3.5	80.9
15 to 16	76.1	23.8	5.0	15.4	3.4	82.0
16 to 17	75.4	24.6	5.0	16.5	3.1	84.1
17 to 20	73.8	26.2	5.0	18.2	3.0	85.8

QUALITY OF CROP.

In making any estimate of the quality of the beets raised in Colorado in 1897 it is of course unfair to use any of the analyses made of crops that were known to be unripe. By the middle of October it is fair to presume that the sugar content had about reached its full limit. There were 51 samples reported after that date, ranging from 10.5 per cent sugar with a purity coefficient of 72.4 to 20.9 per cent sugar with a purity coefficient of 85.3, the average being 15.5 per cent sugar with a purity coefficient of 81.6. What has been done by these growers on their first attempt ought certainly to be equaled on a large scale for factory use when they are better acquainted with the best methods.

IDAHO, 1897.

The results of the past year were rather disappointing. Only 41 samples were analyzed, including 20 from the station; though seed was distributed gratuitously to 114 farmers, representing 41 sections, yet only 40 farmers forwarded beets from 13 localities. Late distribution of seed, insect pests, jack rabbits, drought, and insufficient care were factors that contributed to failure. Samples analyzed, 41; sugar content, 15.17; purity, 87.55. The 20 samples grown by the station gave in sugar 15.28, in purity 92.55. The 21 samples grown elsewhere gave in sugar 15.07, in purity 82.78. The highest readings were 19.00 and 95.10 in sugar and purity respectively; the lowest, 10.1 and 81.81. Places represented were Genesee, Moscow, Kendrick, Juliaetta, Rathdrum, American Falls, Payette, Paris, Leduc, Clarkia, Anderson Newport, and Grangeville.

ILLINOIS, 1897.

Analyses of sugar beets from station farm.

Laboratory number.	Harvested and analysed.	Average weight.	Sugar in beets.	Sugar in juice.	Solids in juice.	Purity coefficient.
		Ounces.	*Per cent.*	*Per cent.*	*Per cent.*	
1	Sept. 14	10.8	13.2	13.9	16.8	82.5
2	do	10.6	13.8	14.6	17.5	83.1
3	do	8.8	13.7	14.4	16.8	85.6
4	do	9.3	13.4	14.1	16.7	84.1
Average		9.9	13.5	14.3	17.0	83.8
5	Sept. 21	11.2	14.1	14.8	17.9	82.9
6	do	9.4	14.7	15.5	18.2	85.0
7	do	7.6	13.4	14.1	17.2	82.3
8	do	9.2	13.7	14.4	17.2	84.0
Average		9.4	14.0	14.7	17.6	83.6
9	Sept. 28	9.4	14.1	14.8	17.8	83.2
10	do	12.8	13.6	14.3	17.3	82.6
11	do	9.4	13.7	14.4	16.9	85.1
12	do	10.0	14.8	15.5	18.2	85.4
Average		10.4	14.1	14.8	17.6	84.1
13	Oct. 5	10.8	15.3	16.1	19.2	83.5
14	do	14.2	14.9	15.7	18.9	83.0
15	do	12.6	13.6	14.3	17.1	83.6
16	do	12.0	14.5	15.3	18.2	84.1
Average		12.4	14.6	15.4	18.4	83.6
17	Oct. 12	12.6	13.2	13.9	16.7	83.4
18	do	14.6	13.4	14.1	16.7	84.2
19	do	12.8	14.0	14.8	17.3	85.1
20	do	13.2	14.3	15.0	17.6	85.1
Average		13.3	13.7	14.5	17.1	84.5
21	Oct. 19	13.8	13.6	14.4	17.3	83.0
22	do	12.0	15.2	16.0	19.1	84.0
23	do	19.6	14.2	14.9	17.4	85.6
24	do	16.6	14.0	14.7	17.3	85.0
Average		15.5	14.3	15.0	17.8	84.4
25	Oct. 26	12.6	14.3	15.1	18.0	83.8
26	do	13.4	13.4	14.1	17.0	83.1
27	do	9.8	14.2	14.9	17.5	85.2
28	do	13.4	14.0	14.8	16.7	88.6
Average		12.3	14.0	14.7	17.3	85.2
29	Nov. 2	13.0	13.5	14.3	17.4	81.9
30	do	15.6	13.8	14.6	17.5	83.2
31	do	12.6	14.7	15.5	18.4	84.2
32	do	15.6	14.7	15.5	17.9	86.6
Average		14.2	14.2	15.0	17.8	84.0
33	Nov. 9	14.8	14.1	14.9	17.9	82.8
34	do	12.8	16.1	16.9	19.8	85.3
35	do	13.6	15.3	16.1	18.8	85.8
36	do	12.8	15.4	16.2	18.6	87.0
Average		13.5	15.2	16.0	18.8	85.2
37	Nov. 16	19.2	14.3	15.0	17.6	85.5
38	do	19.8	13.4	14.1	17.0	82.9
39	do	17.8	14.8	15.1	17.8	84.8
40	do	19.2	14.4	15.2	18.1	84.1
Average		19.0	14.1	14.9	17.6	84.3

IOWA, 1898.

Record of sugar beets grown at the Iowa Experiment Station.

Statement of conditions.	Harvested Oct. 15.		Harvested Oct. 22.		Harvested Oct. 29.		Harvested Nov. 4.		Harvested Nov 11.		Average.	
	Sugar.	Coefficient of purity.	Sugar.	Coefficient of purity.	Sugar.	Coefficient of purity.	Sugar.	Coefficient of purity.	Sugar.	Coefficient of purity.	Sugar.	Coefficient of purity.
	P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*	
Plowed and subsoiled	12.75	84.24	11.92	80.95	12.11	80.27	12.83	79.61	12.98	78.09	12.40	80.35
Just plowed	13.21	82.19	12.16	81.51	12.95	79.74	14.54	85.13	12.50	76.16	12.95	80.95
Just cultivated	13.04	79.08	12.48	79.20	13.55	88.40	15.72	84.99	13.21	80.37	13.10	82.40
Rows 16 inches apart	13.11	82.09	13.06	84.65	12.35	88.98	14.30	85.42	12.98	76.82	13.14	82.51
Rows 20 inches apart	13.44	84.01	12.75	82.18	13.30	87.19	14.43	86.82	12.30	76.25	13.28	83.09
Rows 28 inches apart	12.30	82.37	12.11	81.30	12.83	86.00	14.30	84.93	11.26	75.42	12.48	82.14
Rows thinned to 6 inches	12.08	82.24	11.27	79.22	13.32	87.29	13.86	88.04	11.61	74.12	12.46	82.18
Rows thinned to 12 inches	13.08	84.34	11.98	79.96	12.08	86.00	13.83	86.14	12.42	77.88	12.79	82.57
2 tons lime	12.55	80.49	12.06	80.16	12.30	88.50	14.30	86.40	12.30	75.80	12.70	81.27
1½ tons lime	13.53	79.85	12.65	82.51	13.75	88.71	14.43	89.13	11.68	76.16	13.00	83.17
1 ton lime	11.71	75.07	11.76	80.58	12.98	89.51	14.08	85.85	12.08	80.60	12.62	82.33
No lime	12.98	83.24	12.54	82.08	13.45	89.50	14.30	86.40	11.38	73.44	12.90	82.92
400 pounds salt	12.44	82.53	13.44	84.72	13.95	89.45	13.95	85.29	13.51	83.30	13.46	85.08
300 pounds salt	12.08	79.97	12.37	83.14	12.27	82.17	13.72	84.79	13.11	80.84	12.70	82.18
200 pounds salt	12.29	80.51	12.27	81.91	13.08	85.55	14.61	86.18	12.08	79.27	12.85	83.08
100 pounds salt	12.16	84.71	12.91	83.57	12.81	80.91	13.60	82.98	13.41	82.17	13.20	82.75
No salt	12.64	83.08	11.98	81.74	13.21	83.43	14.01	87.58	11.40	73.52	12.60	81.87
20 tons farmyard manure	12.27	84.21	11.01	76.05	11.84	78.81	13.54	85.68	12.33	78.90	12.30	80.75
10 tons farmyard manure	12.37	78.62	11.84	78.91	13.24	88.86	13.68	87.58	12.22	78.32	12.67	81.48
No manure	11.50	77.90	12.24	80.53	12.54	82.98	13.60	86.27	11.47	75.50	12.31	80.64
Average	12.58	81.50	12.23	81.23	12.88	84.89	13.94	85.93	12.29	77.58	......	......

MINNESOTA, 1897.

BEETS GROWN IN DIFFERENT PARTS OF THE STATE.

There have been about 1,000 samples of sugar beets raised by farmers in different parts of the State, which have been sent to the experiment station for analysis. Including the beets grown at the experiment station, the general average of the entire State for the years 1888 to 1898 has been:

Sugar, per cent	14.23
Purity coefficient	81.2
Total number of samples tested	1,351

The average record for each year is as follows:

	1888.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Average per cent sugar	13.4	12.9	14.1	15.0	15.2	17.2	15.6	13.7	15.0
Average purity coefficient	83.1	79.5	80.1	84.6	84.4	86.6	85.6	81.0	83.3
Highest sugar content	20.3	17.9	20.4	19.1	18.4	19.4	20.6	18.2	18.3
Number of samples tested	111	55	465	185	15	14	22	25	308

BEETS GROWN AT EXPERIMENT STATION.

For sugar-making purposes the beet juice should contain 12 per cent sugar and possess a purity of at least 80. The average per cent of sugar in the juice for each year has been as follows:

Year.	Sugar.	Coefficient of purity.	Number of samples.
	Per cent.		
1890	13.2	81.1	12
1891	15.0	83.3	108
1892	14.9	86.3	73
1893	16.4	85.2	10
1894	17.4	87.6	10
1895	16.6	86.5	10
1896	15.6	82.4	10
1897	16.3	85.6	128
Average and total	15.55	85.6	361

NEVADA, 1898.

Variety.	Date of analysis.	Average weight.	Sugar in juice.	Sugar in beet.	Coefficient of purity.	Station number.
		Ounces.	*Per cent.*	*Per cent.*		
Gebruder Dippe	Oct. 21	15.0	16.80	15.96	84.46	1007
Vilmorin White	do	11.0	17.00	16.15	84.60	1008
Kleinwanzlebener	do	20.0	15.20	14.44	78.26	1009
Pitchker's Elite	do	11.0	16.50	15.68	74.66	1010
Vilmorin's Improved	do	17.0	15.80	15.01	84.54	1011
French Very Rich	do	9.0	17.00	16.15	85.20	1012
Zeringer	do	9.0	19.00	18.05	83.84	1013
Schreiber's Elite	do	12.0	20.06	19.47	88.06	1014
French Very Rich	Nov. 2	13.0	19.00	18.05	87.72	1015
Vilmorin Improved	do	12.0	18.00	17.10	85.07	1016
Schreiber's Elite	do	13.0	21.00	19.95	89.26	1017
Kleinwanzlebener	do	9.0	19.30	18.32	86.71	1018
Zeringer	do	11.0	18.40	17.48	86.13	1019
Gebruder Dippe	do	14.0	19.00	18.05	81.73	1020
Vilmorin White	do	13.0	20.30	19.28	95.98	1021
Pitchker's Elite	do	13.0	21.40	20.33	87.27	1022
Vilmorin Improved		19.0	16.00	15.20		1023
Do		17.5	17.50	16.62		1024
Do		23.0	18.00	17.10		1025

In case of the last three given in the table, the beets were raised by H. A. Commins, Ely, White Pine County, at an altitude of 6,400 feet.

These are the only samples received from the State at large, and probably will be the only ones, as the season has been far too dry for experimental work, the farmers needing all their water for regular crops.

NEW MEXICO, 1897.

Summary of results of analyses.

Where grown.	Number of samples.	Weight.	Sugar in beets.	Coefficient of purity.
		Pounds.	*Per cent.*	
Whole State	105	1.75	14.54	77.2
Northern counties	70	1.72	15.29	79.7
Southern counties	35	1.80	13.55	73.7
San Juan County	14	2.00	16.46	81.3
Taos County	4	1.17	17.42	80.7

NEW YORK, 1897.

Results of analyses of sugar beets grown in different counties, made at Geneva Station.

County.	Amount of sugar in beet.	Amount of sugar in juice.	Coefficient of purity.
	Per cent.	*Per cent.*	
Albany	16.2	17.1	81.0
Broome	14.3	15.0	81.1
Cayuga	12.9	13.6	74.0
Chautauqua	14.7	15.5	82.4
Clinton	15.7	16.5	80.5
Columbia	16.0	16.8	82.0
Cortland	14.4	15.2	79.6
Erie	15.5	16.3	82.3
Genesee	14.1	14.8	79.2
Lewis	14.8	15.6	86.5
Madison	15.7	16.5	82.5
Monroe	15.2	16.0	86.5
Oneida	15.4	16.2	83.5
Ontario	15.5	16.3	82.3
Orleans	14.6	15.4	84.2
Oswego	14.3	15.1	87.3
Otsego	16.3	17.2	86.9
St. Lawrence	16.1	17.0	84.2
Wyoming	14.7	15.5	81.6

In order to determine the actual yield of perfectly clean beets, topped as they would be when sent to the factory, a lot weighing 1,000 pounds was thoroughly washed and dried, after which the crowns were removed.

		Pounds.
Weight of beets taken		1,000
Loss by washing	49	
Weight of crowns	73	
	—	122
Weight of washed beets without crowns		878

At this rate the yield of topped, washed beets was 14 tons 577 pounds; of topped, unwashed beets, 15 tons 200 pounds. At $4 per ton the returns per acre would not be over $60.

A careful chemical examination of these beets gave the following results:

Sugar in beets	per cent	15.2
Sugar in juice	do	16
Coefficient of purity		81

OHIO, 1897.

Summary of results by counties.

County.	Number of samples.		Average weight of beets.	Total solids in juice.	Sucrose in juice.	Purity coefficient.
	Analyzed.	In average.				
			Grams.	*Per cent.*	*Per cent.*	
Ashland	4	4	831	16.7	12.7	76.0
Ashtabula	2	2	679	18.0	14.9	82.8
Auglaize	9	6	1,128	18.7	14.4	77.0
Belmont	1	1	660	19.1	16.6	86.9
Champaign	1	1	825	17.0	13.2	77.6
Clark	11	11	610	17.9	14.1	78.7
Columbiana	1	1	610	22.0	18.4	83.6
Coshocton	4	4	800	17.7	12.9	72.9
Crawford	7	7	1,095	17.9	13.8	77.1
Cuyahoga	4	4	894	17.1	12.9	75.5
Darke	44	44	864	17.3	13.3	76.9
Defiance	23	23	851	17.6	13.7	77.9
Delaware	4	4	550	18.8	14.9	79.3
Erie	1	1	1,406	18.6	15.0	80.6
Fairfield	5	5	500	17.1	12.8	74.9
Fayette	2	2	620	18.5	14.6	78.9
Franklin	5	5	524	19.1	15.3	80.0
Fulton	24	24	1,095	17.8	14.1	79.2
Geauga	6	6	694	19.2	16.3	84.8
Greene	11	11	1,285	14.8	9.9	66.8
Hardin	4	3	798	16.3	12.1	74.2
Henry	33	25	810	18.9	15.3	80.9
Highland	1	1	840	19.3	13.2	68.4
Hocking	1	1	1,321	12.2	7.2	59.0
Holmes	6	6	690	16.8	13.6	81.0
Huron	1	1	303	21.0	16.0	76.1
Knox	4	2	642	19.4	15.9	81.9
Lake	5	3	780	18.0	14.9	82.7
Licking	11	10	562	15.9	11.9	74.9
Logan	2	2	779	16.1	12.8	80.0
Lorain	1	1	520	19.7	16.0	81.2
Lucas	32	30	880	18.2	14.3	78.5
Madison	5	5	711	18.6	14.3	76.8
Marion	7	1	555	16.0	12.4	77.5
Medina	6	5	947	18.2	13.9	76.2
Mercer	11	10	1,119	17.1	13.2	77.2
Miami	12	12	773	16.6	12.6	75.9
Montgomery	8	3	755	16.1	11.8	73.5
Muskingum	5	5	566	18.4	14.4	78.2
Ottawa	13	13	694	19.9	15.7	78.8
Paulding	9	9	802	19.5	15.6	80.0
Perry	1	1	127	23.6	19.1	80.9
Pickaway	1	1	710	20.2	16.5	81.6
Pike	1	1	595	18.0	14.0	77.8
Portage	2	2	1,554	13.3	9.3	69.7
Putnam	19	19	958	17.1	13.1	76.5
Richland	2	2	496	19.9	16.6	83.4
Ross	31	30	697	17.6	13.5	76.6
Sandusky	3	2	812	18.6	14.8	79.6
Seneca	10	10	782	19.1	14.8	77.5
Shelby	8	8	697	17.5	14.0	80.0
Stark	8	8	712	18.9	15.2	80.8
Summit	28	23	684	18.3	14.7	80.2
Tuscarawas	4	4	865	18.7	14.8	79.1
Union	2	2	1,077	19.7	15.9	80.6
Van Wert	21	15	1,064	17.1	12.5	73.1
Wayne	97	89	787	17.2	13.9	80.7
Williams	3	3	979	20.2	16.2	80.2
Wood	25	24	777	18.4	14.4	78.3
Wyandot	1	1	605	18.9	15.1	79.8
Southern section	69	67	892	17.0	12.8	75.3
Middle section	146	132	924	17.8	13.9	78.0
Northern section	392	355	834	18.0	14.3	79.4
Total	607	554	867	17.8	14.0	78.7

OREGON, 1897.

Analyses of sugar beets grown in Union County (a); also averages for Washington, Clackamas, and Jackson counties.

Laboratory No.	Grower.	Average weight.		Per cent of sugar in—		Coefficient of purity.	Solids not sugar.	Solids.	Reported yield in tons.	Date of planting.	Date of harvesting.
		Grams.	Ounces.	Juice.	Beets.						
1096	L. Oldenburg	966	34.1	15.5	14.7	88	2.0	17.5	24.0	....	....
1097	Ed. Gaines	450	15.9	16.4	15.6	86	2.7	19.1	35.0	May 10	Oct. 20
1120	J. L. Caviness	520	18.3	14.3	13.6	89	1.6	15.9	15.0	May 20	Sept. 20
1123	Turner Oliver	556	19.6	18.2	17.3	92	1.7	19.9	15.0	....do....	....do..
1124	W. A. Baker	242	8.5	19.3	18.3	88	2.8	22.1	....	....	....
1125	C. W. Horsley	510	18.0	16.2	15.4	85	2.8	19.0	....	....	....
1126	L. J. Roe	673	23.7	17.9	17.0	88	2.4	20.3	....	May 20	Sept. 20
1127	....do	306	10.8	20.4	19.4	94	1.3	21.7	12.0	....do....	....do..
1128	J. E. Hough	171	6.0	19.1	18.1	83	3.8	22.9	24.0	....do....	....do..
1211	F. A. Mead	376	13.2	16.6	15.8	88	2.1	18.7	....	....	....
1218	Turner Oliver	395	14.0	18.0	17.2	91	1.6	19.6	....	....	....
1231	W. H. Miller	315	11.1	17.5	16.6	88	2.3	19.8	13.0	May 20	Oct. 21
1232	P. A. McDonald	466	16.4	14.9	14.1	88	2.0	16.9	25.0	....	....
1233	Turner Oliver	522	18.4	17.0	16.1	94	1.0	18.0	....	....	....
1234	W. E. Wordell	287	10.1	13.3	12.6	87	2.0	15.3	20.0	May 20	Oct. 20
1235	R. M. Hough	607	21.4	18.2	17.3	90	2.0	20.2	33.0	....do....	Oct. 22
1236	C. W. Neeley	546	19.2	15.8	15.0	78	4.5	20.3	28.0	....do....	....do..
1237	E. W. Oliver	576	20.3	20.0	19.0	94	1.1	21.1	23.0	....do....	Oct. 20
1238	Wm. Hall	489	17.2	17.5	16.6	88	2.4	19.9	24.0	May 24	....do..
1239	Turner Oliver	584	20.6	16.6	15.8	97	.5	17.1	20.0	May 20	Oct. 21
1240	C. W. Riddle	524	18.4	18.1	17.2	92	1.6	19.7	33.0	....do....	Oct. 20
1241	Ed. Graves	682	24.0	15.0	14.3	92	1.3	16.3	....	....	....
1242	Jas. M. Call	566	20.0	20.0	19.0	93	1.4	21.4	20.0	May 20	Oct. 10
1243	Jno. Hough	308	10.9	20.9	19.8	91	2.0	22.9	18.0	....do....	Oct. 22
1244	L. Oldenburg	566	20.0	18.4	17.5	94	1.2	19.6	31.0	....	....
1246	Wm. Thompson	304	10.7	19.0	18.0	90	2.0	21.0	22.0	May 20	Oct. 20
1247	Jno. Neealy	621	21.9	15.2	14.4	89	1.7	16.9	28.5	....do....	Oct. 22
1271	Henry Linch	362	12.8	18.7	17.8	90	1.9	20.6	....	....	....
1109	Ed. Gaskill	238	8.4	20.3	19.3	89	2.5	22.8	30.0	May 15	Oct. 22
	Average	477	16.8	17.53	16.7	88.5	2.04	19.56	23.74	....	....
Averages for—											
	Washington County	407	14.3	16.6	15.3	86.7	2.4	18.2	15.7	....	....
	Clackamas County	507	17.9	13.8	13.07	85.4	2.4	16.2	17.4	....	....
	Jackson County	437	15.4	15.5	14.07	81.01	3.4	18.44	16.1	....	....

a The beet-sugar factory at Lagrande, Oreg., is in Union County.

SOUTH DAKOTA, 1897.

Summary of results in different sections of the State.

Region.	Number beets analyzed.	Average weight.	Per acre.	Stand.	Solids in juice.	Sugar in juice.	Sugar in beet.	Purity coefficient.	Ash in juice.
		Grams.	*Tons.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*
Big Stone Lake region	29	392	20.5	81	17.6	15.5	14.58	87.8	0.89
Upper Sioux River region	225	427	16.9	76	17.1	14.7	13.99	86.0	0.95
Lower River region	222	425	20.2	77	18.9	16.4	15.56	86.6	1.06
Central James River region	50	299	22.1	67	18.1	15.7	14.92	86.9	1.23
Upper James River region	194	360	15.8	78	18.6	16.0	15.23	85.8	1.04
Upper Missouri River region	53	430	13.4	71	18.8	16.4	15.51	86.8	1.13
Central Missouri River region	75	336	21.3	77	19.7	16.8	15.91	84.8	1.19
White River region	9	376	29.0	100	19.5	16.0	15.20	82.0	1.08
Black Hills region	66	281	12.5	81	20.6	16.8	15.95	81.6	1.12
Butte region	28	407	23.8	57	22.4	19.6	18.61	87.7	1.34
Average and total	951	383	21.9	77	19.1	16.4	15.55	85.6	1.09

VERMONT, 1897.

The officers of the Vermont station, while skeptical as to the likelihood of this industry ever proving profitable in Vermont, undertook to place the seed and did so. The remarkably wet spring and early summer of 1897 well-nigh ruined the crop. Out of 100 experimenters but 27 were able to report and to send samples. Because of the peculiar meteorological conditions of the year the writers do not feel like laying stress upon the results. The experiment is being repeated this year (1898) with, at the date of writing (July), better prospects of success. The analytical data are presented herewith as a matter of record, to be discussed, if at all, when further work has been done. Whether Vermont sugar beets will analyze as well when grown in seasons of moderate rainfall remains to be seen:

County and town.	Name of experimenter.	Total solids.	Sugar in juice.	Sugar in beets.	Purity coefficient.
		Per cent.	*Per cent.*	*Per cent.*	
Addison, Addison	John Perkins	23.30	18.32	17.40	78.63
Addison, North Ferrisburg	L. M. Macomber	20.54	17.27	16.41	84.10
Addison, Starksboro	G. F. Bushnell	20.20	17.29	16.43	85.60
Do	do	20.22	16.06	15.28	79.44
Bennington, Manchester	N. M. Canfield	....	13.00	12.35	....
Caledonia, East Hardwick	T. G. Bronson	21.25	17.81	16.92	83.82
Caledonia, South Ryegate	W. N. Gilfillan	18.00	15.78	14.99	87.66
Do	do	22.27	18.99	18.04	85.28
Chittenden, Burlington	Experiment Station	21.09	16.94	16.09	80.32
Do	do	18.80	16.12	15.31	85.74
Chittenden, Essex	H. E. Tomlinson	19.73	16.15	15.34	81.86
Chittenden, Hinesburg	H. A. Beecher	15.34	11.76	11.17	76.66
Do	do	17.91	12.90	12.26	72.03
Do	A. Sykes	24.40	19.41	18.44	79.54
Do	do	20.19	17.79	16.90	88.12
Chittenden, Westford	L. A. Perry	22.49	20.32	19.30	90.35
Chittenden, Williston	M. W. Clark	19.44	15.98	15.18	82.20
Essex, Canaan	A. Frizzell	23.00	20.56	19.53	89.40
Franklin, East Fairfield	J. Mitchell	20.00	18.00	17.10	90.00
Franklin, East Georgia	J. B. Truax	20.74	17.54	16.66	84.58
Franklin, Fairfax	G. G. Orton	20.60	18.24	17.33	88.54
Grand Isle, Pearl	Edward Gordon	20.68	18.00	17.10	87.04
Grand Isle, South Hero	H. D. Allen	23.08	19.08	18.11	82.72
Orange, East Braintree	V. I. Spear	21.90	19.95	18.95	91.10
Rutland, Castleton	S. Giddings	23.48	20.64	19.61	87.90
Rutland, Poultney	F. W. Spaulding	21.97	18.14	17.23	82.57
Washington, Northfield	Chas. Dole	22.80	20.01	19.01	87.76
Windham, East Putney	G. T. Aplin	19.70	17.39	16.52	88.28
Windham, Guilford	J. E. Gale	19.50	15.47	14.70	79.34
Windham, Townshend	J. H. Ware	18.72	14.82	14.08	79.13
Windham, Vernon	E. O. Lee	19.67	16.94	16.09	86.12
Windsor, Woodstock	Geo. Aitken	....	12.62	11.99	....

WASHINGTON, 1897.

Summary of results on experimental tracts from one-half to an acre each.

Locality.	County.	Date of analysis.	Number of sample.	Average weight.	Average sugar in beet.	Average sugar in juice.	Average purity.	Poorest sample.			Best sample.		
								Sugar in beet.	Sugar in juice.	Purity coefficient.	Sugar in beet.	Sugar in juice.	Purity coefficient.
				Ozs.	P. ct.	P. ct.		P. ct.	P. ct.		P. ct.	P. ct.	
Puyallup	Pierce	Oct. 21	50	17	17.1	18.0	89.1	13.5	14.2	87.0	19.2	20.2	94.0
Chehalis	Lewis	Nov. 1	50	23½	16.4	17.2	85.1	11.1	11.7	75.0	19.0	20.0	93.0
Ellensburg.	Kittitas	Nov. 2	52	14	17.1	18.0	88.2	14.7	15.5	81.1	19.0	20.0	90.1
Hartford	Snohomish	Nov. 6	50	12	17.0	17.9	88.8	14.6	15.4	81.9	20.0	21.1	89.1
Nooksachk	Whatcom	Nov. 21	50	19	15.6	16.4	89.1	11.9	12.5	80.1	18.0	19.0	93.1
Dayton	Columbia	Nov. 29	50	11	13.6	14.3	81.3	8.1	8.5	73.5	17.4	18.3	90.5
Vancouver.	Clarke	Nov. 30	51	34	14.2	15.0	87.2	10.0	10.5	75.6	17.8	18.7	90.7
Orting	Pierce	Dec. 3	56	18	16.8	17.7	92.7	12.9	13.6	82.4	20.9	22.0	89.4
Waverly	Spokane	Dec. 5	55	17	18.5	19.5	89.4	12.1	12.7	78.9	22.4	23.6	92.9
Crescent	Lincoln	Dec. 7	57	8	15.8	16.6	87.8	10.0	10.5	80.2	19.2	20.2	90.2

In the experiments in production of beets by irrigation, the averages for 68 samples are as follows: Sugar in juice, 17.6 per cent; sugar in beet, 16.7 per cent; purity coefficient, 85.2. These averages are of course lower than they would be if the samples included that were immature when harvested were eliminated. The figures need no comment. They speak volumes concerning the possibilities of Washington as a sugar-producing State, and of the adaptability of our irrigated regions to sugar-beet culture.

WISCONSIN, 1898.

The samples of beets analyzed under this head numbered 253, of which 102 were taken at about a month before harvest, and 151 at harvesting time; the samples were furnished by 121 different farmers. The average results of the analyses, arranged by counties, are given in the following table:

Results of analyses of sugar beets, average by counties, 1898.

County.	First samples.				Samples taken at harvest.				
	Number of samples.	Average weight of beets.	Sugar in juice.	Coefficient of purity.	Number of samples.	Average weight of beets.	Sugar in juice.	Coefficient of purity.	Yield per acre.
		Lbs.	Per ct.			Lbs.	Per ct.		Tons.
Ashland	1	0.8	17.16	84.3	1	1.0	15.63	77.4	....
Barron	1	.8	13.94	70.0	2	1.3	14.11	82.4	5.0 (1)
Brown	7	2.1	14.52	78.9	3	1.9	15.65	83.8	15.7 (3)
Burnett	1	1.3	14.29	77.3	2	1.1	13.33	72.8	7.9 (1)
Calumet	....	....	....	....	2	.6	21.32	83.6	9.2 (2)
Chippewa	2	.7	16.55	80.1	2	1.2	16.09	77.8	9.0 (2)
Clark	5	1.0	15.92	78.5	10	1.2	15.90	78.5	13.7 (2)
Columbia	....	....	....	....	2	1.7	14.58	73.6	....
Crawford	4	1.5	12.39	79.7	1	1.3	18.61	82.5	8.0 (1)
Dane	4	2.0	13.56	77.1	4	2.0	12.58	73.0	15.0 (3)

Results of analyses of sugar beets, average by counties, 1898—Continued.

County.	First samples.				Samples taken at harvest.				
	Number of samples.	Average weight of beets.	Sugar in juice.	Coefficient of purity.	Number of samples.	Average weight of beets.	Sugar in juice.	Coefficient of purity.	Yield per acre.
		Lbs.	*Per ct.*			*Lbs.*	*Per ct.*		*Tons.*
Dodge	3	.6	13.56	75.6	3	1.1	15.86	78.5	17.7 (2)
Door	2	1.7	14.51	73.8	1	2.3	14.58	79.4	6.4 (1)
Douglas	1	.8	16.86	88.9	2	1.1	16.82	83.7	15.4 (2)
Dunn	3	1.3	15.55	78.6	3	1.3	15.05	76.7	14.1 (3)
Forest	2	1.1	12.67	74.4	......	......	......	......	......
Green Lake	......	......	......	......	1	2.1	15.54	80.5	16.0 (1)
Iowa	......	......	......	......	1	1.3	14.54	72.1	......
Jackson	1	1.3	17.57	83.2	8	1.2	16.87	82.0	6.0 (1)
Jefferson	2	2.4	10.61	67.6	14	1.7	13.89	76.1	26.0 (1)
Juneau	1	1.5	14.18	78.0	1	1.7	15.88	82.0	16.0 (1)
Kenosha	......	......	......	......	1	2.4	15.88	73.9	14.6 (1)
Kewaunee	3	1.2	13.21	77.4	7	2.2	15.59	75.6	10.5 (1)
La Crosse	3	1.5	12.41	74.1	3	1.6	12.88	74.3	13.5 (1)
Lafayette	1	1.4	17.32	77.2	1	1.9	12.54	73.8	9.0 (1)
Lincoln	3	.9	17.49	84.4	4	.8	19.11	81.3	10.1 (1)
Manitowoc	2	1.1	15.00	75.8	4	1.4	14.20	73.7	8.6 (2)
Marathon	2	1.4	12.87	66.2	2	1.8	16.80	83.3	12.0 (2)
Marinette	3	1.0	16.16	82.6	3	1.3	15.62	79.9	14.7 (3)
Marquette	1	1.3	15.90	82.8	2	.8	15.77	77.6	15.9 (1)
Milwaukee	1	2.8	11.92	77.4	1	2.5	12.97	78.4	......
Monroe	2	.5	13.64	76.1	1	.6	20.45	78.4	11.0 (1)
Oconto	1	.8	20.74	86.2	3	1.1	14.46	76.0	9.1 (2)
Oneida	1	1.5	16.44	82.9	2	1.0	19.18	77.8	6.1 (2)
Outagamie	8	1.4	12.77	79.1	10	1.7	12.87	72.7	17.1 (2)
Ozaukee	2	2.0	15.39	81.0	2	2.0	13.24	75.6	11.4 (1)
Pepin	......	......	......	......	2	1.3	18.24	81.6	......
Pierce	......	......	......	......	2	1.1	15.95	73.5	......
Polk	2	1.7	12.78	74.9	......	......	......	......	......
Price	1	.8	17.31	79.7	3	.8	16.82	80.5	6.2 (1)
Racine	1	1.7	16.54	81.6	1	2.1	17.50	83.7	20.0 (1)
Richland	1	1.2	13.24	74.1	1	1.3	13.88	75.2	......
Rock	......	......	......	......	2	1.8	14.24	79.0	15.0 (2)
St. Croix	6	1.4	15.84	78.2	5	1.1	16.61	81.2	9.6 (4)
Sauk	3	1.0	15.62	83.5	1	.3	19.71	84.1	6.0 (1)
Shawano	1	1.4	13.77	77.8	......	......	......	......	......
Sheboygan	2	.7	17.35	83.6	2	1.1	12.76	84.1	12.0 (1)
Taylor	......	......	......	......	1	1.0	19.93	80.4	10.0 (1)
Trempealeau	1	.7	16.04	80.0	1	.9	13.23	72.9	9.5 (1)
Vilas	1	1.5	19.00	84.4	......	......	......	......	......
Walworth	2	.9	17.81	80.9	4	1.5	15.95	76.7	14.5 (3)
Washington	2	1.4	16.10	80.6	1	1.4	15.87	85.5	16.5 (1)
Waukesha	2	1.3	15.72	81.7	2	1.5	15.74	79.2	15.6 (3)
Waupaca	......	......	......	......	3	1.8	12.71	72.7	9.9 (1)
Waushara	2	1.5	16.86	84.3	5	1.2	15.84	84.3	16.5 (3)
Winnebago	1	2.2	14.77	79.8	1	2.7	16.90	79.9	10.7 (1)
Wood	1	.9	16.99	83.3	1	.7	17.67	83.5	10.8 (1)
Not identified	......	......	......	......	3	1.6	14.59	75.7	......
Averages	102	1.35	14.84	78.8	151	1.44	15.36	78.0	12.6(73)

FACTORY CONDITIONS PREVAILING IN VARIOUS STATES AND TERRITORIES, AS REPORTED BY OFFICERS OF EXPERIMENT STATIONS.

The success of a sugar-beet factory in a community depends upon so many conditions that it was deemed wise to investigate the question of conditions in the various States and Territories and to publish the results. A factory after it has been built, equipped, and capitalized is dependent for all time to come upon the local conditions, and should not, therefore, be projected on any vague or visionary ideas of those conditions. It was thought best to secure this information as to factory conditions from persons who understand the shipping facilities, trade relations, and resources of the States in the way of crude materials and labor necessary to the manufacture of beet sugar.

Hence I addressed a letter to each of the directors of the State agricultural experiment stations in the United States which are taking part in the sugar-beet experiments. The reports received in answer to this communication follow. A majority of the stations which were requested to furnish this information have submitted reports. In the case of several no reply was received.

The following is a copy of the letter sent to the directors of the stations calling for this information. After the letter the replies are given by States in alphabetical order:

LETTER OF INQUIRY.

WASHINGTON, D. C.

DEAR SIR: You kindly offered to furnish as much data along the line of the beet-sugar industry in your State as possible. The Secretary of Agriculture is very desirous that the facts touching this industry in your State be fully and faithfully recorded in my report. He has been making the beet-sugar industry in the United States one of the chief subjects of investigation by several branches of his Department. There are a few salient and important points that should come out in a complete report of the conditions of a State which do not appear in ordinary station bulletins, these being usually confined to tabulated statements of results of chemical analyses and facts in regard to the growing of beets.

There is, however, another side to this question which might be called the factory side. A State may be able to grow very desirable beets and still not have conditions that would put it in line to compete with other States that have very favorable factory conditions. I wish to name some of these conditions, and, if the facts are not at your hand, I wish you would get the best-posted men available to report upon them. I request this in order that your State may be as fully and fairly reported as possible, and I think this can be done by men in the State and on the ground.

I will be glad to give credit in the forthcoming report to those who kindly furnish this information.

In answer to the following questions the desired information can be reported, the answers being numbered to correspond with the questions, or arranged in other suitable form:

(1) What conditions would a factory in your State have in the way of markets, transportation, proximity to trade centers, etc.?

(2) Factories require a large amount of fuel, usually crude petroleum or coal. What is used in your State, and whence comes the supply? What does it cost delivered?

(3) Factories require a large amount of limestone, which must be unusually pure limestone, free from the natural impurities which impede the process of making sugar. What about the resources of your State in the way of limestone?

(4) Factories require a large amount of pure water. What about the water supply for this purpose in your State?

(5) Other conditions being right, stock feeding becomes an immediate factor in connection with the factory; for instance, cattle and sheep feeding, dairying, and creameries follow in the wake of a well-regulated factory. What prospect does your State offer along this line?

(6) Anything else of interest that you may wish to report on this subject will be thankfully received.

An early reply is desired.

Very respectfully,

CHARLES F. SAYLOR,
Special Agent, Department of Agriculture,
in charge of Sugar-Beet Investigation.

COLORADO.

Report by W. W. Cooke, Agriculturist of State Experiment Station.

In the experimentation with sugar beets in the State of Colorado this year, the beets were tested from week to week, but they did not show much increase in sugar until the last few days when the sugar in the beet jumped up 3.5 per cent. The indications of the experiments are that the beets in these localities should not be harvested before October 15. The beets analyzed after this date ranged in per cent of sugar from 10 to 18½, the average being 14 per cent of sugar. The coefficients of purity ranged from 70 to 89, the average being 80.7. This was a poor year for Colorado, and if beets show up well this year, it certainly indicates that they will do well under normal conditions. For convenience we recognize the following districts in Colorado:

First, the valley of the South Platte and its tributaries.

Second, the Divide south of Denver and the Plains Region (where beets are grown without irrigation).

Third, the valley of the Arkansas River.

Fourth, the valley of the Grand River.

Fifth, the San Luis Valley.

In all except the second district irrigation is employed.

The two things of most interest here are the quality of the beets when ripe, and the time of ripening as influencing the length of campaign. Study of the conditions may enable the farmer to have his beets mature, say, two weeks earlier.

Average sugar content and purity of beets harvested on different dates in October, 1897, in the different districts of the State.

Districts.	Samples harvested between Oct. 1 and 10.		Samples harvested between Oct. 10 and 15.		Samples harvested after Oct. 15.	
	Sugar.	Purity coefficient.	Sugar.	Purity coefficient.	Sugar.	Purity coefficient.
	Per cent.		*Per cent.*		*Per cent.*	
Valley of South Platte and its tributaries	14.1	80.7	14.6	81.1	15.4	61.1
Divide south of Denver, and Plains Region	12.5	73.7	15.1	80.6	14.8	78.3
Valley of the Arkansas River			13.1	77.9	15.3	81.9
Valley of the Grand River	16.3	83.6				
San Luis Valley	13.7	79.2	12.4	78.5	14.8	80.3

ADVANTAGES OF LOCATION.

A few words of explanation seem necessary in regard to the above results. The Arkansas Valley is about 150 miles south of the valley of the Platte, and consequently the beets ripen nearly two weeks later. The ripe crops of the two valleys are practically the same. The beets grown in the valley of the Grand River, which is on the Pacific slope of the range, ripened earlier than those in corresponding latitudes on the eastern slope. They were fully ripe and ready for the factory by the first week in October. This is about the same date at which they ripened in this valley during the season of 1896.

The results from the divide and the plains are quite irregular. Since the beets grown there are dependent entirely on rain, and since our Colorado rains are largely local, the results are quite problematical. The sections that received rains when needed show excellent results, while those receiving the same amount of rain, but not at the proper time, show largely failures.

RESULTS IN THE SAN LUIS VALLEY.

The San Luis Valley presents a still different phase of the problem. The beets were grown here at an average altitude of 7,500 feet. The time between the spring and fall frosts is rather short to make the crop certain. The average results are somewhat below those of the other sections of the State, and yet there are several samples that show over 16 per cent of sugar and a coefficient of purity of 84. This indicates that the soil and climate even in this section are favorable to the beet, and that the low average results can be overcome by better care of the crop.

CONDITIONS FAVORABLE TO MANUFACTURE OF BEET SUGAR.

From the manufacturer's standpoint Colorado offers special advantages. The home demand would take all the sugar that would be produced by two large factories east of the Range and one west. The valleys of the South Platte, the Arkansas, and the Grand are places in the State that seem to offer the best factory facilities. These districts have the water to secure full and certain irrigation for the crop. The canals and ditches are already constructed. The settlers are already on the ground; are used to employing this water for potatoes, corn, and other farm crops; and can easily adapt their farms and methods to the cultivation of the sugar beet.

Colorado has inexhaustible supplies of coal and limestone, the two articles most used by the beet-sugar factory. Each of the three valleys named has large deposits of excellent coal. This could be delivered to a factory at any place in the valley of the South Platte for $2 per ton; in the valley of the Arkansas the price would be $3, while in the valley of the Grand, a price of $3 per ton delivered could be obtained. Along the foothills of northern Colorado are enormous deposits of limestone of a quality especially adapted to use in sugar factories. This could be delivered ready for use at from $1 to $1.50 per ton, depending on the location of the factory. In the valley of the Arkansas are also found large deposits of much the same quality, and the cost would be but little greater. All along the Grand River any quantity of the finest limestone can be obtained within distances so short that it could be hauled by team.

The question of the water supply would be one of the most serious, and would to a great extent determine the exact location of any factory that may come to the State. In northeastern Colorado, the towns of Loveland and Longmont are both supplied with water direct from the mountains that would answer all requirements. At all other points in the valley of the South Platte the factory would have to depend on wells, and but few of the wells now in use in this region furnish water that could be used for a sugar factory. Fortunately there are at least two places, Rocky Ford and La Junta, in the center of the farming district, where artesian wells furnish an unlimited supply of the best quality of water. A factory could be placed almost anywhere in the valley of the Grand River and get an abundant supply of the finest water. The valleys of the Platte and the Arkansas are already largely interested in sheep and cattle feeding. Every ton of beet pulp would find immediate use for feeding to stock. Within 10 miles of Fort Collins there are at the present time enough lambs on feed to consume all the pulp from three large sugar factories. Any one of several places in the valley of the Arkansas has similar conditions. In the valley of the Grand there is nothing corresponding and the demand for beet pulp would have to be created.

Colorado has been a good deal interested in the growing of sugar beets for the past eleven years. The interest the past season has been greater than ever before. Associations for promoting the growth of the beets and securing the erection of factories have been formed at Fort Collins, Brighton, Fort Morgan, Sterling, Rocky Ford, and Glenwood Springs, while the chamber of commerce of Denver is taking a very active interest in the matter.

The foregoing report covers all the specific points mentioned in Mr. Saylor's letter. Our conditions here are very favorable for the manufacture of sugar from beets. It would be difficult for any place in the United States to show as good a combination of soil, climate, water, fuel, lime, cheap rates for transportation, and home market for the product.

ILLINOIS.

Report by E. DAVENPORT, Director of Illinois Experiment Station.

Sugar-beet seed was distributed to about 600 farmers in the State, with instructions for growing and reporting. For various reasons only about 400 samples of beets were received in fit condition for analysis. All badly wilted specimens were rejected, and no abnormally high percentages of sugar will be found in the tables. Nearly every sample is from the seed distributed by the station, and furnished by the Department of Agriculture at Washington. In no case is the analysis from a single beet reported. The general plan was to analyze a sample of the mixed juice from six beets. In some cases but four were taken, and in rare instances but two.

Our people are not accustomed to growing beets, and, as might have been expected, directions for planting and cultivating were not always well followed. In many cases the planting was too deep, resulting in an uneven stand. Frequently the rows were 3 feet or more apart, and in many cases the entire lot of seed was planted in a single row. Under such circumstances it is not surprising that some of the samples were below standard, and the uniformly satisfactory purity coefficient seems eminently favorable.

Very little can be said concerning the yield, considering the circumstances under which these beets were grown. Experience elsewhere, however, leads us to suppose that this matter of yield is of less concern upon our rich prairie soils than is the question of purity. There is little doubt of the ability of our soils to produce enormous crops. That grown upon the station farm yielded from 10 to 14 tons of marketable beets under very ordinary conditions and upon land that had been cropped for many years. A number of injuries were reported. These were by live stock breaking in, by potato bugs, or by the false chinch bug (*Nysius angustatus*), and not, as many supposed, by the true chinch bug, whose diet is confined to the members of the grass family.

The tabular results of analyses are arranged upon an arbitrary division of the State into three sections—northern, central, and southern. The distribution is such as to cover with great completeness all portions of the State excepting the so-called white-clay lands of the south, which can not be said to have representation here, and upon which further experiments are necessary before any opinion can be advanced concerning their fitness for growth of sugar beets. The section in question is one of four or five counties lying between Effingham and Odin.

Besides data touching the growth of beets there are certain general considerations that influence the prospect of the State at large as a sugar-producing region. A few of these, upon which reliable information is at hand, are briefly touched upon below.

LABOR.

Illinois is exceedingly well supplied with a labor force. It is at present largely gathered in towns and about the mining districts, but there is every reason to suppose that our large labor population can be attracted to the beet fields as well as to the coal mines and the broom-corn regions. This is particularly promising when we remember that the large number of coal mines in the State employ only the mature men of the family, leaving a labor contingent unemployed that is exceedingly acceptable for the hand labor of beet growing.

COAL AND LIME.

There are 874 coal mines in the State, with a yearly output of something over 17,000,000 tons. This abundant supply of soft coal over nearly all of the State south of the Illinois River, together with excellent facilities for cheap transportation, brings the cost exceedingly low. Prices range from $1 a ton up. The State is nearly everywhere underlaid by coal and lime, but in the absence of a State agricultural and economic survey a letter of inquiry touching the Illinois supply of coal and lime was addressed to Prof. C. W. Rolfe, geologist of the university. His reply is quoted herewith in full:

Prof. E. DAVENPORT, *Director Experiment Station.*

DEAR SIR: Referring to your recent inquiry regarding the limestone and coal deposits of our State which could be made available for the manufacture of sugar from beets, will say I deeply regret my inability to give you the specific information you desire.

The geologic investigations which have heretofore been undertaken by the State were confined almost exclusively to stratigraphy and paleontology, leaving our natural resources practically untouched. I earnestly hope this will be remedied in the near future.

First, as to coal: If a line be drawn from Danville, Vermilion County, through Paxton, Ford County, Wilmington, Will County, Rock Island, Rock Island County, thence south, following the general direction of the Mississippi, but at a distance of, say, 25 miles eastward to the north line of Union County, thence east to the State line, all counties, with very few exceptions, included in the closed area would be able to furnish coal of suitable quality and in sufficient quantity to meet all probable demands, and to counties without this area our many lines of railroad are able to supply coal almost as cheaply.

Second, as to limestone: Very few analyses of Illinois limestone have been made, but, basing an opinion on these and a considerable field acquaintance with the rocks of the State, I do not hesitate to express the opinion that accessible deposits can be found in at least four-fifths of the counties, which will meet your requirements. I append a short list of typical outcrops, which I feel sure would meet your demands:

Trenton limestone (blue), Galena, Jo Daviess County.
Trenton limestone, Thebes, Alexander County.
Niagara limestone, Grafton, Jersey County.
Niagara limestone, Joliet, Will County.
Hamilton limestone (gray), Rock Island County.
Oriskany limestone, Jackson County.
Burlington limestone, Gladstone, Henderson County.
Burlington limestone, Quincy, Adams County.
Keokuk limestone, Nauvoo, Hancock County.
St. Louis limestone, Rosiclare, Hardin County.
Chester limestone, Chester, Randolph County.

There are also many deposits in the coal measures which would be suited to this use.

Respectfully submitted.

C. W. ROLFE,
Professor of Geology.

WATER.

A glance at the map of Illinois will show that the State is abundantly supplied with running water, but for the work of diffusion a supply of deep-well water being required, a letter asking for explicit information concerning the character of the subsurface-water supply was forwarded to Prof. A. W. Palmer, chemist of the university, who has in charge a systematic survey of the waters of the State. His reply is quoted in full:

Prof. EUGENE DAVENPORT,

DEAR SIR: In reply to your query regarding the water supplies of Illinois with respect to the use of water in the manufacture of sugar from beets, I would say that in most regions of the State water that is sufficiently pure for this purpose is available. In some districts of the State waters drawn from the deeper wells are charged with a considerable amount of chlorides, and in some cases of sulphates, but through most of the sections of the State waters drawn from drift wells and also those drawn from wells in rocks are comparatively free from sulphates or chlorides, the mineral waters consisting mainly of carbonates of calcium and magnesium, and would be well suited to use in the manufacture of beet sugar. Some deeper drift wells yield waters which are charged with considerable quantities of organic matters, but these are present in less quantity than is commonly found in surface waters, that is, river and lake waters; consequently, in my opinion, they would be serviceable in this manufacture.

Yours, very truly,

ARTHUR W. PALMER,
Professor of Chemistry.

TRANSPORTATION AND MARKETS.

Besides enjoying the advantage of four navigable rivers, Illinois is better supplied with railroads than is any other State in the Union. One hundred and nine separate lines are operated within the State, with an aggregate length of over 10,500 miles, and with 2,740 stations. This vast mileage is in the hands of about sixty great companies, whose trunk lines communicate with the East and with the West, with the Great Lakes and with the Gulf, and focus at the great trade centers, Chicago and St. Louis. Of the 102 counties of the State, but three are without railroad facilities. Two of these lie upon the Ohio River and one between the Mississippi and the Illinois. A substantial advantage to the railroads of Illinois is the uniformly easy grade over which maximum loads may be hauled at minimum cost.

I am satisfied that the greatest work that remains to be done is the education of the people in what is practically to them not only a new system of agriculture, but a new kind of contact with extensive manufacturing enterprises. I believe that concerted effort from all directions ought to be exerted in such ways as shall induce the people to put forth both individual and community effort to learn the details of growing paying crops of marketable beets, and to know and to be willing to observe proper relations with factory interests. It is easier to arouse enthusiasm than to so direct it that prosperity and not failure shall ensue. This is all intended to mean that in the opinion of this station the great work that remains to be done is to educate the people, or to induce them to educate themselves, and that for this purpose the locality or the community and not the individual should be considered the unit.

INDIANA.

Report by C. S. PLUMB, director of State Agricultural Experiment Station.

MARKETS.

Probably no State in the Union has better market facilities than Indiana. The State capital, Indianapolis, at the center, has 180,000 population; Chicago, at the northwest corner of the State, has over 1,000,000 population; St. Louis, 265 miles west, has 500,000; Cincinnati has 300,000 more; Cleveland, 283 miles northeast, has 300,000; Pittsburg, 381 miles northeast, has 250,000; Louisville, opposite our southern boundary, has 170,000; Detroit, 250 miles northeast, has over 200,000. In northeastern Indiana, Fort Wayne has 50,000 inhabitants; in southern Indiana, Evansville has 50,000; in northwestern Indiana, Lafayette has 25,000; in western Indiana, Terre Haute has 35,000.

Of the 92 counties in the State 89 are penetrated by railroads, and the entire State has between 6,000 and 7,000 miles of railway. All the large towns, such as Indianapolis, Fort Wayne, Lafayette, Terre Haute, Richmond, Evansville, and New Albany, have railroads entering them from several points of the compass, thereby giving first-class railway connections.

FUEL.

Seven thousand square miles of Indiana are underlaid with coal veins, and 4,000,000 tons were mined in 1897. The price of this coal, which is bituminous, ranges from 80 cents to $1.05 on board the cars at the mine. Indiana is also becoming an important petroleum State. In 1897, 4,200,000 barrels of petroleum were produced in the State. The average market price of this oil was 43 cents per barrel at the well. Over quite a large territory natural gas is also extensively used, although the future supply is more or less problematical. I will inclose a map showing the territory covered by coal, petroleum, and natural gas. You will see from this that a good portion of central and northeast-central Indiana is occupied by natural gas and petroleum.

LIMESTONE.

A large section of Indiana is underlaid with limestone. No purer limestone exists than the oölitic, which occupies an area of from 5 to 12 miles in width, extending from Putnam County, in the western central part of Indiana, to the Ohio River, on the southern boundary. Numerous chemical analyses show it to contain more than 98 per cent of calcium carbonate. The supply is practically inexhaustible in the area mentioned. Niagara limestone outcrops in a number of other localities, in White, Carroll, Cass, Miami, Wabash, and Huntington counties, but it contains several per cent of magnesium. Taking the judgment of our State geologist, and he is an entirely competent man, there is a large amount of limestone which will be entirely suited to use in sugar-beet manufacture.

WATER.

Indiana is covered with a network of rivers and lakes, while in most parts of the State, particularly in the best sugar-beet territory, good water can be secured from driven wells. The water of our lakes, however, which are all over northern Indiana, is unusually pure. Both the chemist of this station and the university chemist, men who have made special study of the sugars and beet-sugar production, insist that our water is of an unusually satisfactory character and in suitable abundance.

STOCK FEEDING.

Indiana is first and last an agricultural State. In every county in the State may be found very large numbers of dairy cattle or beef cattle, sheep, and swine. The creamery and dairy interests are making a most excellent growth, and there is no question but that, if factories are built in our State, the refuse material can be readily disposed of for feeding stock.

SOIL ANALYSES.

There has been no agricultural survey of the State with special analyses made of the soils in different sections and of the different classes. I wish, however, to lay special emphasis on this fact, that for ten years now this experiment station has been carrying on its sugar-beet investigations most persistently, so that beets have been grown in all sections of the State and the roots analyzed at this station year after year. We feel, as a result of this extended investigation, that there is no question as to the adaptability of a large portion of Indiana to the successful growing of the beet for sugar production. Last year, in order to get a correct idea of the adaptability of certain sections, the 500 pounds of beet seed sent us by the Government were sent to certain localities in the State, where blocks of land ranging from one-fourth of an acre to 1 acre were planted. In the vicinity of Fort Wayne and North Judson most satisfactory returns were secured from these extensive plantings, and in the Kankakee Valley, in particular, the percentage of sugar found in the juice of the beet was very high indeed, one beet running to 22.9. In those parts of the State where sugar-beet organizations have been established the people are aggressive and intelligent, and it is my firm belief that factories established in any of these communities will be able to secure the proper support from the farmers, who will produce beets yielding an entirely satisfactory amount of sugar. I might state in connection with this subject that Henry County, where one sugar-beet organization has been established at Newcastle, is one of our leading dairy counties, with a number of creameries.

IOWA.

Report by C. F. CURTISS, Director of the State Experiment Station.

(1) This State annually pays about $6,000,000 for sugar, all of which is imported from outside sources. The transportation facilities are of the very best and cover every county in the State.

(2) The State is abundantly supplied with good coal, and the richest deposits are found in the central section—the region of Des Moines and Boone—and the southern and southeastern parts around Oskaloosa and Muchakinock.

(3) In reply to question No. 3, the following copy of a letter received from Prof. Samuel Calvin, State geologist, is submitted:

> Replying to your letter of January 4, I would say that we have in Iowa an abundance of limestone as pure as it is possible for limestone to be. First, at the so-called State quarries in Johnson County there are great beds of limestone composed exclusively of organic structures, cemented with pure calcite; second, we have in the Kinderhook volite another form of pure limestone. Dr. Beyer's report on Marshall County, Iowa (Geol. Surv., Vol. VII, pp. 197-262), describes this volite as it occurs at the Legrand quarries, and on page 251 there is an analysis of this stone by Professor Patrick. The impurities are—

Silica, etc	per cent..	0.77
Alumina	do.....	.05
Ferrous oxide	do	.09
Total	do.....	.91

> The small amount of magnesium oxide is hardly an impurity, for such an amount is inseparable from every limestone, no matter how formed, and so, leaving that out, the total impurities are less than 1 per cent. This, I venture to say, is not excelled anywhere. There are extensive beds of volite equally pure at Humboldt and at many other points in Iowa. That at Legrand is most accessible. Machinery for quarrying and facilities for shipping are already provided.

(4) The State is abundantly supplied with good water. Nearly all localities of the State have deep wells affording an inexhaustible supply of water that would probably in most cases be entirely satisfactory for sugar-making purposes. The report of the Iowa Agricultural College water supply contains on pages 16 and 17 reports of analyses of water from deep wells at Ames, Boone, Cedar Rapids, Greenville, Davenport, and Sioux City.

(5) In the live stock and dairy industry Iowa ranks foremost among the agricultural States of the Union.

KANSAS.

Report by J. T. WILLARD, Chemist of the State Experiment Station.

Our State is well situated with respect to markets, and has excellent facilities for transportation to Kansas City, St. Louis, Chicago, and the West.

SUPPLY OF COAL, WATER, AND LIMESTONE.

The eastern part of the State has an abundance of coal, which can be obtained at a low price. I can not give exact figures. In the southeastern part of the

State petroleum has been obtained in quite a number of places, especially in the vicinity of Neodesha, Wilson County. I am informed that the price for fuel petroleum free on board in tank cars at Neodesha has been 60 cents per barrel. The present output of the region is about 200 barrels per day, and about 150 barrels per day are taken by the present demand. Mr. C. W. Owston, of the Standard Oil Company, can give but little information as to the future prospects, but thinks they are not very favorable.

This State is well supplied with limestone in many portions. I have no analyses available, but am informed that the State University Geological Survey will publish within the next year analyses of over 100 of the limestones of the State.

The water of the State is generally good. Some few streams are brackish. The Kansas, Republican, Smoky Hill, Solomon, Blue, Verdigris, Neosho, and Marais des Cygnes rivers, and doubtless some of the larger creeks would supply an abundance of water. The water of the Arkansas River is, except in times of flood, all taken out in Colorado or western Kansas for irrigation; but there seems to be a large supply known as the underflow a few feet below the surface through the Arkansas Valley.

Cattle raising and feeding is one of the chief industries of this State. Comparatively few sheep are fed here, I think. The dairy industry is now in its infancy, but I feel confident will grow rapidly in importance. I think there would be no difficulty in utilizing suitable by-products of beet-sugar factories in feeding cattle.

AVERSION TO AGRICULTURE INVOLVING HAND LABOR.

I know of no localities in the State which have manifested an organized interest in the sugar-beet industry recently, although from newspaper items I am led to believe that such interest exists in one or two places. My impression is that the most interest has been manifested where the natural conditions as respects fuel and limestone are the least advantageous. The chief difficulty with our farmers here at present is that they are not likely to undertake agriculture involving much hand labor. In some of the older portions of the State agriculture is in a much more advanced stage than in others, but in few localities probably has it risen to the stage of advancement that successful beet culture demands. I have no data worth mentioning upon soil analyses. There is no question, however, as to the fertility of our soils. The main difficulty will be to obtain proper culture. I intend to continue the sugar-beet investigation in this State with increased energy. Our seasons begin early here, compared with many of the other States, and I consider it highly important that our beets should be planted early, so that they may be well grown before the summer droughts.

MICHIGAN.

Report by E. D. Smith, Director of the Michigan Experiment Station.

(1) Factories in this State have every possible facility as far as markets are concerned. In the first place the State borders on the Great Lakes, and is thus put in water communication with Chicago, Milwaukee, and other lake ports to the west, and with Buffalo and the Erie Canal on the east, besides the ports along the Great Lakes. The railroad facilities are unsurpassed, as the State is crossed east and west and north and south by trunk lines, with branches extending to every proposed location of a factory.

(2) As to fuel, no State could be better supplied than Michigan; transportation from the South is cheap, and moreover the central part of Michigan is underlaid by soft coal, which is being mined at Saginaw and Bay City and can be laid down at the sites of sugar factories very cheap. This coal is, of course, strongly bitumi-

nous. If wood is suitable for that class of factories, of course we have immense forests of hard wood which would be within reaching distance.

(3) The outcrops of limestone furnish an article of unusual purity. The quarries on each side of Siginaw Bay show less than 1 per cent of impurities. There is an outcrop at Trenton, south of Detroit. Limestone can be furnished at the proposed sites of factories at small cost, because of the facility with which it can be transported by water.

(4) At all points bordering on the Great Lakes there is no possible question about the water supply. At inland points the dependence would have to be on the rivers, small creeks, and artesian wells. The State as a whole is crossed by a large number of streams that would furnish water.

(5) Michigan is distinctly a live-stock State, and could easily add to the number of cattle fed either for meat or milk a sufficient quantity to consume all the pulp from the factories which are possible or probable. Our people are used to stock feeding, and there need be no apprehension of waste from negligence on this line.

This station is ready to cooperate with the efforts of the Secretary of Agriculture in developing the beet-sugar industry in this State to the utmost of its possibilities.

MINNESOTA.

Report by Harry Snyder, Chemist of the State Experiment Station.

HOME MARKETS.

The cities of Duluth, St. Paul, and Minneapolis have a combined population of over 400,000. It would take all the product of three and one-half beet-sugar factories to supply the cities named. The calculations are based on a hundred days' working season and a daily capacity of 300 tons of beets per factory, the average amount of sugar consumed per capita being 65 pounds. It would require all of the product of fourteen such factories to supply the State with sugar. The pineries and the wheat farms of the State all require more than the average amount of sugar.

OTHER MARKETS CONTROLLED.

In addition to supplying the home demands, the States of North Dakota, Montana, and Idaho would afford an outlet for surplus sugar. St. Paul and Minneapolis being the natural trade centers of the Northwest, the States mentioned would afford markets which competing States could not well control, because all sugar supplied to the Northwest must pass through Minnesota.

TRANSPORTATION FACILITIES.

There are six lines of railway running west and northwest through the State, not counting the numerous side lines. The nine railway lines from Minnesota to Chicago would afford an outlet for all surplus sugar over the amounts required for home consumption and the northwestern trade. Lake Superior, in the northeastern part of the State, and the Mississippi River, along the eastern boundary, afford additional facilities for obtaining crude materials and shipping the finished product. There is scarcely a locality in Minnesota which is not favored with two or more lines of railway.

FUEL SUPPLY OF THE STATE.

The information regarding the fuel supply of the State has been supplied by Mr. Morin, of the Albert Lea Commercial Club, and Mr. Randall, of the Winona Board of Trade. What is true of these places would in general hold true for the central, southern, and eastern parts of the State, as well as many other localities.

Mr. Morin writes: "Lump coal is to-day (January 6, 1896) laid down here for $2.20 to $3.50, f. o. b." Mr. Randall writes: "The coal used extensively as fuel here costs on an average about $2.75 per ton, delivered. Slabs from our sawmills can be bought very cheaply during the sawing season, and when dry they make good fuel. Price of slabs, about $1 per cord. Sawdust can be procured without charge; it has been very extensively used by two large flouring mills."

There is no question but that the demand of a sugar beet factory for fuel would be met with reduced prices. There is some refuse from oil refineries that could be utilized, as well as some peat deposits. Lignite can also be obtained at a very low figure.

LIMESTONE.

The State is well supplied with limestone. The southern and western parts of the State are underlaid with limestone rock. Ledges of the rock are exposed along the streams and in other places. The limestone is mostly of the dolomite variety. As a rule it is free from alkaline compounds. It will average from 92 to 96 per cent pure magnesium and calcium carbonates. The limestone contains from 3 to 5 per cent of sand, and no carbonate of soda or potash. The analyses of stone from Winona, Red Wing, Lanesboro, and Fountain, made by Professor Dodge in 1896 for the State geological survey, are as follows:

Constituents.	Winona. No. 1.	Winona. No. 2.	Red Wing. No. 3.	Lanesboro. No. 4.	Fountain. No. 5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Silica	3.98	1.31	10.94	7.35	9.89
Alumina	1.40	.72	.34		
Oxide of iron	1.13	.55	.55	1.05	1.30
Carbonate of lime	51.65	53.95	50.68	62.14	86.11
Carbonate of magnesia	41.62	42.89	33.61	28.49	.47
Phosphate of lime	.10	.07	Trace.		
Manganese	Trace.	None.			
Potash	Trace.	Trace.			
Soda			.15	.24	
Organic matter and moisture	Trace.	Trace.	.68	.02	.44

The dolomite limestone from other localities in the State has about the same general composition. While it is a dolomite limestone, it is to be observed that it carries no impurities, as chlorides, alkaline carbonates, and phosphates, which cause trouble in sugar manufacturing operations. Samples of pure limestone, as No. 5, are also to be found in the State.

WATER.

Lakes.—There are a large number of small lakes in the State, which are fed from springs. The water from nearly all of the lakes is free from alkali and is all that could be desired for beet-sugar purposes. The lake waters carry about 40 grains per gallon of solid matter, which is composed mainly of limestone. There are but few localities in the State where objectionable alkaline water is found.

Artesian and deep wells.—An ample supply of pure water can be obtained from either artesian or deep wells in nearly every part of the State. As an example, the water supplied by the station is from a well 280 feet deep, which has a capacity of 150 gallons of water per minute. The well has never given signs of a low-water supply. The water is practically free from organic matter and alkalies. It gives no reaction for sulphates. Water of the same quality is quite generally found in the State. In some localities the water is only 20 feet from the surface. Numerous analyses of water from various parts of the State have been made by the Minnesota Experiment Station, which show that, as far as the quality and quantity of the water are concerned, the State is unusually well supplied.

UTILIZING THE BEET PULP.

As to utilizing the beet pulp for stock feeding, it is only necessary to say that the live stock and dairy industries are already developed in the State, and it would not be necessary to wait for these adjuncts of the beet-sugar industry to be developed. There is annually fed around the St. Paul stock yards 265,000 head of sheep, and in the State there are over 400 creameries. The live-stock industry in many parts of the State has improved the methods of farming to such an extent that Mr. Morin says, "One of our strong arguments is that we have a population ready and competent to take up this industry, and can thereby eliminate the expensive experiment of trying to make good farmers out of poor ones."

EXTENT OF EXPERIMENTS IN SUGAR-BEET CULTURE.

Experiments in the culture of sugar beets have been carried by the Minnesota Experiment Station since 1888. The results are given in the following tables:

Beets grown in Minnesota from 1888 to 1897.

	1888.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Average per cent sugar	15.4	12.9	14.1	15.0	15.2	17.2	16.6	13.7	15.0
Average purity coefficient	83.1	79.5	80.1	84.6	84.4	86.6	85.6	81.0	83.1
Highest per cent sugar	20.3	17.9	20.4	19.1	18.4	19.4	20.6	18.2	18.5
Number of samples analyzed	111	55	465	185	15	14	22	25	303

General average, nine years, 1,351 samples: Sugar, 14.22 per cent; purity coefficient, 81.2.

Average of beets grown at experiment station.

Number of samples.	Year.	Sugar in beets.	Purity coefficient.
		Per cent.	
12	1890	13.2	81.1
106	1891	15.0	82.5
73	1892	14.9	86.3
10	1893	16.4	85.2
10	1894	17.4	87.6
10	1895	16.6	88.5
10	1896	15.6	82.4
128	1897	16.3	85.6

General average, eight years, 361 samples: Sugar, 15.55 per cent; purity coefficient, 85.8.

In addition to the analyses of beets, the experiment station has sent beets to the beet-sugar factories in Nebraska. In the fall of 1892 a carload of sugar beets grown on the experiment station farm at St. Anthony Park was sent to the sugar-beet factory at Grand Island, Nebr. President Oxnard wrote as follows:

> FEBRUARY 24, 1893.
>
> DIRECTOR OF THE EXPERIMENT STATION,
> *St. Anthony Park, Minn.*
>
> DEAR SIR: In reply to your favor I will say that your beets were most excellent in every respect, both as to size and quality. If this kind of beets can be grown on a large scale, there is no doubt whatever of the adaptability of the soil in your neighborhood to the growth and development of sugar beets. The test showed 14.9 per cent of sugar with a high purity coefficien
>
> Very truly, yours,
> HENRY T. OXNARD.

The year that these beets were sent to the factory (1892) 73 samples of beets raised at the station tested 14.9 per cent sugar. These results are given in Bulletin No. 27, which was published about a month before the receipt of this letter. It is to be observed that the factory tests and the laboratory tests are identical. The beets were paid for on the basis of 14.9 per cent sugar.

MONTANA.

Report by S. M. EMERY, Director of the Montana Experiment Station.

(1) Montana consumes 10,000,000 pounds of sugar per annum, and there certainly would be a market for this amount, as our people are growing rapidly to a proper appreciation of supporting a home industry. We are on a main line of railway between the coast and the great inland lakes, in all of which territory there is at present no other home production of sugar to be considered as competition. If given a fair show by the transportation companies, as it would no doubt be, there ought to be market along the line of the Northern Pacific Railway for the product of a first-class plant located in Montana.

(5) Montana ships 250,000 beef cattle to Eastern markets each fall. These could, with great profit, be fed in the State (or half of them, at any rate) with a combination of grain and alfalfa with the beet pulp. This would have a beneficial effect upon the cattle market. This State is also the leading sheep State of the Union, and there is a very strong call on the part of sheep men for mutton sheep to cross upon the fine-wool flocks now universal in the State. Many thousands of sheep are winter-fed on alfalfa for mutton. Here, then, would be a way to help out both the flock master and the farmer by supplying this valuable accessory to the feed ration.

Dairying is yet in its infancy, and it would receive substantial aid by the establishment of a sugar plant.

Industries of this nature bear much promise in Montana. We have facilities and reserves here to comfortably maintain and support a population exceeding that of any of the older States at present, and this development to come offers much to insure a permanency of market.

Following is the letter of Dr. F. W. Traphagen, chemist of this station, answering questions 2, 3, 4, and 6 of the circular:

DEAR SIR: (2) We have coal fields within 10 miles of Bozeman, which produce a good quality of bituminous coal. This coal costs from $3.50 to $4.50 per ton in small quantities. In large quantity I have no doubt coal could be purchased at much lower prices. It has been estimated that fully 50,000 square miles of Montana are underlaid by coal.

(3) Limestone occurs very plentifully in this State and is widely distributed. You will find inclosed analysis of a sample of carboniferous limestone, which forms a large part of the Bridger Mountains, near our town. Other localities where pure limestone occurs are near Helena, in the Jefferson Canyon, and near Missoula.

(4) An analysis of the water of Lyman Creek, which supplies our city, is inclosed. This is a comparatively "hard" water, as are all the waters coming from that side of the valley (the north), where our limestones crop out. On the other hand, the south side of the valley is composed of granite, gneissic, and volcanic rocks, which furnish a much purer water. The larger streams come from this side, and furnish nearly all the water used for irrigation. I regret that I have no complete analysis of this water to submit to you.

(6) Concerning the soil, a statement of the average composition of the soil of the experiment-station farm is inclosed. It may be taken as a type of the soil of this valley. In many parts of the State large quantities of sulphate of soda are contained in the soil.

I have dwelt especially upon conditions in the Gallatin Valley, because I am more familiar with these, and because the only active interest taken in the manufacture of beet sugar is centered here.

Report of analysis of sample of limestone from Bridger Canyon.

	Per cent.
Silica	.85
Alumina and ferric oxid	.30
Lime	54.92
Magnesia	.49
Carbon dioxid (calculated to CaO and MgO)	43.67
Total	100.23

Report of analysis of sample of water from Lyman Creek, showing number of grains in 1 gallon.

	Per cent.
Total solids	11.78
Organic and volatile matter	1.87
Silica	.29
Alumina	.14
Bicarbonate of iron	.07
Bicarbonate of lime	7.27
Bicarbonate of magnesia	5.66
Chloride of sodium	.16
Chloride of magnesium	.12
Sulphate of potassium	.01
Sulphate of calcium	1.36
Temporary hardness	10.26
Permanent hardness	6.12

Report of average obtained by analysis of 21 samples of soil from experiment station farm.

	Per cent
Coarse material	0.567
Fine earth	99.433

Analysis of fine earth.

Insoluble matter	80.41
Soluble silica, SiO_2	.13
Potash, K_2O	.60
Soda, Na_2O	.36
Lime, CaO	1.16
Magnesia, MgO	1.15
Oxid of manganese, MgO_4	.96
Peroxide of iron, Fe_2O_3	3.93
Alumina, Al_2O_3	6.15
Phosphoric acid, P_2O_5	.29
Sulphuric acid, SO_3	.113
Organic matter	6.44
Moisture	4.08
Nitrogen	0.1695

NEBRASKA.

Report by H. H. NICHOLSON, Chemist of the State University and of the State Experiment Station.

I submit the following general discussion of the natural advantages of Nebraska for the culture of sugar beets. I contrast these conditions briefly with those of Germany and other beet-growing countries of Europe. To go more into detail would require more time than I can now spare and more space than you might feel like giving.

At the outset I would remind you that good natural conditions are but a part of the essential conditions for a successful sugar industry. These must be seized, studied, adapted, and made the most of by an intelligent, thoughtful husbandry.

SOIL AND CLIMATE.

Certain varieties of soil and climate are fundamental requirements. With these and intelligent energy to make the most of them, the beet-sugar industry in this State is an assured success.

An ideal soil for the growth and culture of the sugar beet is described as consisting of a mild, moist loam about 20 inches deep, underlaid by loam or marl to the depth of from 3 to 6 feet, the whole resting on sand. The surface should be level or slightly sloping, for ease in cultivation and to avoid the washing away of the young beets by heavy rains. Such soils are easy to cultivate, absorb and retain heat, are self-draining, and act like a sponge in taking up and retaining excesses of moisture for the use of plants in a season of drought. In connection with such a soil we should have a moderately cool climate, or one so conditioned that the period of highest temperature is accompanied or closely followed by that of maximum rainfall. The bulk of the annual rainfall should come during the early part of the season, while the plant is perfecting its root and leaf systems, and gradually diminish during the latter part of the season, the period of maturity, while the beet is increasing its sugar content. Another climatological factor of great importance is the amount of sunshine. This is in reality the chemist who makes the sugar when the apparatus, the leaves and rootlets, have been fully developed.

When these conditions are well met, the beet, as a sugar-producing plant, reaches its highest development. While these are the ideal or standard conditions for beet production, I do not wish to be understood as saying that such perfection of soil and climate is absolutely essential to their successful growth. Beets do well and thrive in soils that do not have all of these qualities, but they will be better in all respects the more nearly we approach to this standard.

Let us turn from this brief statement of what, for want of a better term, I style the ideal conditions of soil and climate, and see how nearly we approach to them in this State.

The soils of Nebraska may be, in general, classed as warm, sandy loams, free from roots and stones, and underlaid, except in a few localities, by sand. In the southeastern part of the State, and on what may be called its river front, is a soil containing a certain admixture of clay, which as we proceed westward gives place more and more to sand until we reach the western and especially the northwestern portions of the State, where the soils are quite sandy and sometimes intermixed with gravel and marl.

The mechanical quality of the soil is characteristic, as a glance at the following tabulation of mechanical analyses will show:

Mechanical analyses of Nebraska soils.

Location.	Fine gravel.	Coarse sand.	Fine sand.	Finest sand.	Silt.	Organic matter and loss.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Ames	....	0.24	4.90	40.39	52.98	....
Do	0.24	9.20	22.90	23.16	44.70	....
Do	.28	3.56	21.34	27.30	47.54	....
Grand Island	....	.54	11.70	62.46	24.30	....
Do	....	.90	10.60	63.30	25.30	....
Norfolk	....	.39	3.40	52.00	44.40	....
College farm	.01	.02	.31	12.44	78.01	10.18
Long Pine	5.19	8.21	7.42	22.39	72.39	6.16
Neligh	.06	.90	10.54	39.36	42.96	8.62
Valentine	.07	1.19	30.53	39.29	25.09	4.81
Wahoo	....	.08	.73	21.37	68.44	9.25
Brokenbow	....	....	.46	32.19	65.01	11.33
Orleans	....	.11	1.11	45.80	45.92	7.08
Bancroft	....	....	....	2.90	87.14	8.84
Red Cloud	.71	2.78	9.64	29.28	52.91	4.78
Benkelman	....	....	.31	29.12	58.68	5.42
Alliance	.42	3.09	30.62	32.11	58.20	4.67
Curtis	....	....	.14	43.77	52.30	5.47
Kimball	8.46	5.62	15.41	32.95	57.63	4.44
Sidney	.07	.19	2.11	45.90	44.79	6.40
Ravenna	....	.01	.40	14.11	78.53	4.37

For comparison I place beside these results of the mechanical analyses of typical beet soils from the province of Saxony, Germany, where the sugar-beet industry is as highly developed as anywhere in the world.

Mechanical analyses of Saxony soils.

Location.	Fine gravel.	Pearl sand.	Coarse sand.	Fine sand.	Finest sand.	Silt.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Klein Wanzleben	0.24	0.25	0.26	1.96	32.78	64.48
Dommitz (Saale)	.56	.26	.42	5.81	19.73	73.09
Korbisdorf	.06	.17	.13	2.06	19.77	77.87
Schilla (Thuringia)	.96	.26	.34	6.08	9.33	83.06

The following results of chemical analyses give some information as to the ultimate composition of Nebraska soils:

Chemical analyses of Nebraska soils.

Constituents.	Dawes County.	Cherry County.	Brown County.	Antelope County.	Saunders County.	Lancaster County.	Hamilton County.
Water	2.5500	1.3730	1.8080	1.9965	1.8700	3.2620	3.5360
Organic substance	4.8200	4.7980	6.0008	5.9022	9.2616	6.5140	8.0160
Silicic acid	85.9070	87.0467	81.2220	83.4188	78.4751	79.5400	83.7560
Ferric oxide	1.1480	1.4794	1.3960	2.3670	1.2620	4.9610	1.2290
Clay	2.7450	2.3965	6.2940	3.6022	7.7873	1.9200	1.1900
Lime	1.3820	.4963	.7736	.3050	.4963	.6100	.4664
Magnesia	.2060	.0546	.0600	.0315	.3345	.4200	.4300
Potash	.0410	.4367	.7410	.3067	.2412	.1970	.0541
Soda	.0900	.3241	.4000	.3678	.2087	9.1240	.0551
Phosphoric acid	.3220	.0623	.0680	.0390	.1127	1.4210	.0047
Sulphuric acid	.0007	.3750	.0970	1.1600	.5790	.0663	.0020
Carbonic acid	1.7120	.9057	1.1800	.0721	.6125	.1600	.0040
Chlorine	.0056	.0036	.0009	.0278	.0028	.1510	1.0041
Nitrogen	.0840	.0569	.0736	.0690	.0710	.0700	.0060

It can be said without exaggeration that the soils of this State, excepting a few isolated localities, are in their composition, drainage, and freedom from roots and stones almost ideal for general farming, and especially for the cultivation of root crops. The underlying sands serve as a drainage system in seasons of excessive rainfall and as a water reservoir when the precipitation is deficient. The seasons of the past decade have given us an abundant proof of the truth of this proposition.

Climatically the State is most admirably situated. Lying, as it does, between the fortieth and forty-third parallels of north latitude, at an average altitude of 2,000 feet above the sea level, it has a season that is in some respects, I think, even better adapted to sugar beet culture than the season in the European sugar belt lying between forty-seven and fifty-four north latitude. Our precipitation is almost altogether in the form of rain. While the annual rainfall in different portions of the State is somewhat irregular, yet there is a pretty regular increase from west to east and from north to south. This irregularity is due to two causes, viz, distance from large bodies of water and altitude.

RAINFALL.

The average precipitation in the State is about 24 inches, varying from about 30 inches in the eastern and southeastern to 18 and 19 inches in the extreme western and northwestern parts. While this rainfall is considerably less than that of some of the Eastern States, yet we have a great advantage in the method of its distribution.

A careful comparison of the rainfall records extending over the last twelve years shows that about 60 per cent of our rain falls during the months of April, May, June, and July; that is, while our total annual rainfall is somewhat less than in States farther east, a great part of it comes at the season of the year when it is most needed for growing crops. It appears from the records of the United States Weather Service that the average amount of rainfall during the months of April to July, inclusive, at Omaha amounts to 18.41 inches; at Yankton, which may represent northeastern Nebraska, 15.58 inches; at Valentine, 12.39 inches. A comparison with the rainfall which occurs over what is known as the Eastern States shows that the eastern part of Nebraska has during these four months, a larger amount of rainfall than the Eastern States from Maine to Virginia, except possibly along the immediate coast, and that the western part of the State of Nebraska during these months is favored with an amount of rainfall but slightly below the moisture recorded in the Eastern States. Thus while Nebraska's annual rainfall is considerably less than that of the States before mentioned, her available rainfall, if I may use this expression, is proportionally much better than that of the States east. Again, comparing the precipitation in Nebraska during these growing months with that in the sugar belt of Europe, we are struck with the very favorable showing for this State. The fall for the European sugar belt in May is a little over 1¼ inches, rising very rapidly to 3¼ inches in June, which figure it nearly maintains until the middle of September, when it falls to about 3 inches in October. For the same months here we have in May a little over 4 inches, gradually increasing until the middle of June, when it reaches about 5 inches, then gradually tapering off to about 3 inches in August and to less than 2 inches in October.

TEMPERATURE.

It is difficult to reduce the temperature of this region to as definite a statement as that of rainfall. The average annual temperature of the State ranges from 50° in the southeastern portion of the State to about 46° in the northwestern. By April the mean temperature has risen to from 40° to 48°, and it increases rapidly during this month and through May, June, and July. A comparison of these results with those of the sugar-growing districts of Europe and with those climatic conditions apparently required for successful sugar production shows but slight differences. In the sugar-producing districts of Europe the average monthly temperature for the months of May, June, July, August, and September does not rise much over 70° nor fall far below 50°. The average monthly temperature for Nebraska for the same months ranges between 58.9° in May to 75° in July, falling to 62° in September. Stated briefly, then, our rainfall during these months is greater than it is in the sugar districts of Europe. Our temperature, also, is slightly higher, but is closely correlated to the rainfall, both temperature and rainfall rising to the maximum in June and July and gradually decreasing during the following months—a condition that is conducive to the formation of sugar in the beets.

In regard to the danger from frost the bulletin on the climate of Nebraska says: "Owing to the prevailing high altitude of this State and the small amount of water present in the air, we are liable to comparatively late spring frosts." The observations of the Signal Service, extending over a comparatively large number of years, have shown with considerable accuracy the latest date at which spring frosts may be expected in different parts of the State, together with the average latest date for several years that killing frosts have occurred. The following table shows, in the order named for the places referred to, (1) the number of years of observation from which the data are drawn; (2) the average date of last killing frost; (3) the earliest date on which the last killing frost occurred; (4) the latest date on which the last killing frost occurred; (5) the percentage of times when the last killing frost has not been more than ten days earlier or later than the average date:

Dates of last killing frost in spring.

Locality.	Length of record.	Date.			Percentage of occurrences within ten days before or after average date.
		Average.	Earliest.	Latest.	
	Years.				
Brownville	7	Apr. 10	Apr. 3	Apr. 23	86
Desoto	17	Apr. 17	Apr. 1	May 7	59
Fremont	15	Apr. 15	Apr. 3	....do....	67
Genoa	12	Apr. 17	Mar. 20	Apr. 30	58
Hay Springs	3	May 15	May 3	May 28	33
Nebraska City	9	Apr. 21	Apr. 6	May 8	78
Ravenna	14	May 9	Apr. 15	June 11	57
Syracuse	5	Apr. 21	Apr. 4	May 9	....
Weeping Water	13	June 2	May 8	June 23	78

Another point to be considered in connection with sugar production from beets is the amount of sunshine received during the year and the distribution of the sunny days throughout the period of growth and maturity. It is interesting to note that in the amount of sunshine our soil receives we are highly favored, as is shown indirectly by the number of rainy days in the summer and autumn months. The following figures for Nebraska are taken from the report of the Nebraska weather service, and are an average of twelve years:

Average number of rainy days.

Locality.	June.	July.	August.	September.	October.
Nebraska	8.5	7.7	6.4	5.8	4.9
Belgium	16.6	15.7	15.0	14.8	14.0

These facts—soils that tend to absorb and hold any excess of moisture, the bulk of the rainfall in the spring and early summer, a large number of sunny days, the amount of sunshine progressively increasing as the season passes—are the most important factors in the whole question of beet production, and in the main they are very favorable to the establishment of that industry here.

Nebraska, with her rich, warm, deep, and mellow soil, her abundant and timely rainfall, and her wealth of sunshine, is adapted not only to the successful growth and cultivation of sugar beets, but she seems intended by nature to be the leader in the successful establishment and building up of the sugar industry in America.

MARKETS.

Turning now from the point of view of the beet grower to that of the sugar manufacturer, the conditions in Nebraska seem equally good. In regard to markets for the manufactured product, the manufacturers in Nebraska would seem to have unusual advantages over those of the coast regions, especially in regard to the matter of transportation. Situated in the interior of the country, he is not subject to the long hauls of the coast-line manufacturer. His market is at his door. Nebraska alone, with the present population of 1,265,000 people, consumes annually the product of from ten to twelve factories, each having a working capacity of 350 tons per day of twenty-four hours, assuming the per capita consumption to be 60 pounds.

If we enlarge this area to include the States immediately surrounding Nebraska, viz, Kansas, Missouri, Iowa, Minnesota, North and South Dakota, having an aggregate population at present, as estimated by their respective governors, of 10,750,000 people, and using the same per capita consumption, we will have an annual demand for over 600,000,000 pounds of sugar, or the product of over 100 factories, each having a capacity of 300 tons per twenty-four hours and working one hundred days in the season.

It will be seen from this statement that in the matter of a market for sugar this State has peculiar advantages. In the matter of reaching the market this region is equally well situated. Within the region above mentioned are the large trade centers of Omaha, Kansas City, Denver, Minneapolis, St. Paul, and Lincoln. Lincoln and Omaha, within the State, are excellent distributing points. Nine railway systems reach Omaha and six trunk lines converge at Lincoln. From these points all parts of the State and the country are easily reached.

FUEL, LIME, AND WATER.

In the matter of fuel this State is easily supplied from Colorado, Wyoming, Iowa, Missouri, and Kansas at very reasonable rates, dependent largely upon the location and volume of business. Petroleum fuel is now being largely used in the factories in the place of coal. This is procured largely, if not entirely, from the Standard Oil Company, the price, as in the case of coal, being dependent on varying conditions.

Limestone for the purification of beet juice is a natural product in various parts of the State. Stone of excellent quality occurs at various points throughout the eastern part of the State, while limestone of a good quality is found in the northern and northeastern portions.

Water in abundance of the purest quality is easily obtainable in any portion of the State suitable for beet growing. As is well known, sugar factories bring in their train a large number of other important industries, especially those of stock growing and stock feeding. The State is well adapted to the production of stock, and produces annually an immense amount of hay, corn, and other grains. In the neighborhood of the factories already established stock feeding is becoming an important secondary industry. The dairy and creamery business has been well established already in the State and will be developed enormously with the further production of sugar beets. The advantages from feeding beet pulp—that is, the exhausted cossettes—are just beginning to be understood by our dairymen. When more definite knowledge has been obtained and distributed among stockmen in general, this will be an important source of revenue to the sugar manufacturer.

Of the 48,000,000 acres, more or less, of land within the limits of the State, at least one-fourth is especially adapted to the production of sugar beets, an abundant area to produce the sugar supply for the States above mentioned. The question of sugar production from beets is a living one here. Many localities have active organizations looking to the establishment of sugar factories in their midst.

GERMINATION EXPERIMENTS.

In reference to the investigations carried out at this station in conjunction with the Department of Agriculture during the season of 1897 I tender the following report:

On or about April 5 we received from the Oxnard Beet Sugar Company, at Norfolk, at the instance of the Department of Agriculture, 500 pounds of Verbesserter Kleinwanzlebener seed. This seed was thoroughly mixed and samples taken for germination experiments. It was then sacked in half-pound sacks and sent out to applicants under Department of Agriculture franks, together with our instructions and a return-report blank. The germination experiments were carried out according to the methods of Frühling & Schultz, modified in some respects by ourselves.

Results of germination tests:

Moisture	per cent	11.18
Foreign matter, chiefly dirt	do	1.36
100 seed bolls gave in fourteen days	plantlets	126
1 kilo of seed contained	bolls	50,450
1 kilo of seed yielded	plantlets	63,567
1 gram of seed yielded	do	63
Number of unviable seed in 100		28

DISTRIBUTION OF THE SEEDS.

The following circular letter was prepared and sent to leading newspapers throughout the State on April 8:

LINCOLN, NEBR., *April 8, 1897.*

DEAR SIR: The university has a small amount of sugar-beet seed for free distribution. We desire to get samples into each county in the State. Will you kindly further this object by publishing the following notice in your next issue:

> Persons wishing to experiment in beet growing this year can obtain a sample of imported seed by addressing Prof. H. H. Nicholson, State University, Lincoln, Nebr. As the available amount of seed is small, apply early, as requests will be honored in the order in which they are received. Analyses of beets raised will be made free of charge by the department of chemistry. Brief directions for planting and cultivating will be sent out with each package of seed.

Seed was distributed in accordance with requests from persons throughout the State. A total of 433 applicants was supplied. Somewhat later in the season a large amount of material in the shape of bulletins, franks for free transmission of seed to Washington, and directions for planting, cultivating, and harvesting of beets was received from the Department of Agriculture for distribution to those who had received seed. As we had already furnished applicants with full instructions according to our own methods, it was at first thought unnecessary to distribute this matter, but under the advice of the director of the station copies were mailed to the address of each one who had received seed. Somewhat later in the season the director of the station was appointed special agent of the Department of Agriculture for sugar-beet investigation. At this time departmental franks for the sending of beets to this station were received, and these also were mailed to those to whom seed had been sent.

REPORTS RECEIVED.

Of the 433 persons who were furnished seed from this station, 158 or about 36 per cent responded in the fall, either by sending beets accompanied by a report, as requested, or by sending a report and no beets.

Of these people in active communication with us, 106 supplied samples of beets for analysis and 54 reported failures. Of the failures reported 26.9 per cent were attributed to dry weather and 26.9 per cent to poor seed; 25 per cent of the failures were caused by grasshoppers, 7.7 per cent by stock destroying the crop, and 13.4 per cent by general neglect. Undoubtedly the small percentage returning beets to the station for analysis is, in part, to be attributed to the confusion arising from their having received franked shipping tags directed to the Department at Washington and also franked shipping tags directing them to send beets to the station at Lincoln. It may be assumed that as many sent beets to Washington as did here. If this is true over 70 per cent of those receiving seed made some sort of return.

The results of our analyses show a total average of 12.34 per cent of sugar in the juice, with a coefficient of purity of 75. The highest per cent of sugar in juice was 16.8 per cent, with a coefficient of purity of 78.5. The lowest per cent of sugar in juice was 4.76 per cent, with a coefficient of purity of 45.

Considering that a large number of these beet growers were entirely without experience in growing beets for a sugar content and that samples came from all portions of the State, including those least adapted to beet growing, this showing is rather remarkable. We sent beet seed into 67 of the 91 counties of the State and received beets from 36 counties.

NEW MEXICO.

Report of ARTHUR GOSS, Chemist of New Mexico Experiment Station.

I inclose herewith some tables showing the principal analytical results that we have secured in the beet work this season. We have not had time to figure the purity and some other points in connection with the analyses, which will be reported later. Considering the fact that practically all the beets analyzed were grown under purely experimental conditions, it seems to me that the results are very encouraging. There is no question that if the matter had been on a business basis, such as would prevail in actual practice, the results would have been higher. Take, for example, the results reported from the station farm here. We know beyond question that the conditions under which most of the samples grew were not the best to secure a high percentage of sugar, as we are trying experiments on time of planting, time of harvesting, variety testing, deep and shallow plowing, and different methods of irrigation. I do not believe there is any question that New Mexico can grow beets containing a high percentage of sugar.

Replying to your questions, I will say—

(1) There is at present but one factory in this part of the country, I believe, and factories established here would have the trade of a very large section of thinly settled country. The larger markets outside of this section would, of course, be open to all.

(2) We have coal in the Territory which can be delivered in the southern portion for about $5 per ton. In the northern portion it is cheaper, selling for about $3 per ton.

(3) We have plenty of limestone in many parts of the Territory. The few analyses that we have made thus far would seem to indicate that limestone of very good quality can be secured. We have just undertaken a survey of the limestones and waters of the principal beet-producing districts.

(4) Water, running from 50 to 100 parts of total solids per 100,000 parts, can be had in the beet-producing sections. We have already made a large number of water analyses from various parts of the Territory.

(5) We import most of our butter from Kansas and other points, and, in my opinion, dairying will pay, at least until the market is overstocked.

(6) The interest in the sugar-beet work seems to be very keen in almost all parts of the Territory where beets can be grown. By referring to the tables you can see what sections have produced the best beets this year. Special mention should be made, I think, of the Rio Grande Valley, especially the northern portion, and the Animas Valley, which latter has a constant and abundant supply of very good water, but at present no railroad. A road is being talked of for that section, however. I consider the Animas Valley one of the most promising sections for the production of sugar beets in the Territory.

The soils of the Territory contain, I think, about an average amount of nitrogen and phosphoric acid and an unusually large amount of potash. Our soils have a decided advantage over the soils in the rainfall districts in that the fertility is largely kept up by the plant food carried in the irrigating water, and nearly all that once gets on the soil remains, as very little is lost by leaching and drainage. This is particularly true in regard to potash, which element I consider practically inexhaustible in these soils. I have discussed the above points somewhat in detail in one of my earlier bulletins, a copy of which I will send you.

NEW YORK.

Report by I. P. ROBERTS, Director of State Experiment Station at Ithaca.

(1) The markets for the products of beet-sugar factories in New York are right at hand. The home markets in the State are sufficient to use up all the products of the factories which we are likely to have for years to come. At the factory in Rome this season it was found that in Rome and Utica nearly the entire supply of the factory was used.

(2) Being located near the coal mines of Pennsylvania, the supply of fuel is near at hand and the price is reasonable. Coal is used mainly. The price varies from $1.75 to $3.25 per ton.

(3) A large portion of the State is underlaid with limestone, which can usually be secured at small cost, and even in sections where the limestone is not found naturally the freight rates are so low that it can be easily secured. In no State is the supply of limestone more available than in New York State.

(4) If the supply of water were the only thing upon which the success of factories depended nearly every section of New York State would be well adapted to manufacturing sugar. There are abundant streams of pure water where the flow is sufficient during the entire year for the supply of a large factory.

(5) There is no State better suited than New York for the manufacture of dairy products and for using the refuse of the factory as stock feed. The demand for high-class dairy products in this State is sure to be greater than the supply. Stock can be purchased cheaply at Buffalo and fed upon the refuse of the factory, and when fattened it is near the market. The creameries of New York have long had a reputation of being among the best in the country, and there is no reason why these creameries should not be increased in number and their products used in the cities of the State. At the present time large quantities of dairy products are shipped into New York from other States, and this product could as well be supplied from the creameries of the State.

OHIO.

Report by CHAS. E. THORNE, Director, and A. D. SELBY, Chemist, of the State Experiment Station.

(1) The population of Ohio is approximately 4,000,000; its annual sugar consumption, therefore, is probably more than 100,000 tons. The State is netted with more than 12,000 miles of railway, including main tracks and sidings, and it is bordered by several hundred miles of navigable water. It has two cities of about 300,000 population each, and two others of more than 100,000 each, besides many smaller cities

(2) The Ohio State geologist, Prof. Edward Orton, places the actual area of the measured seams of coal in Ohio at not less than 5,000 square miles, capable of yielding 23,000,000,000 tons of coal. This great coal field, like the State at large, is netted with railways; and bituminous coal of the best quality is sold throughout the State at prices so low that wood has almost ceased to be used for fuel. The average cost over the State probably does not exceed $2 per ton in carloads for lump coal, with corresponding reductions for lower grades. Not only has the State this good supply of coal, but the largest petroleum field in the United States lies in the State of Ohio, and this is supplemented by two smaller fields in other parts of the State.

(3) Lime is burned in a large way in twenty counties scattered over the western half of the State, and in a smaller way in as many other counties. Limestone occurs in all the coal-producing counties. On the whole, the limestone resources are second to those of no other region known to the writers. Some of these limestones contain more or less magnesia, though they are remarkably free from other impurities; but limes derived from stone containing 85 to 95 per cent of calcium carbonate are worked at the large Ohlemacher quarries of Sandusky, at Owens Station, Marion County, and in Clark and Miami counties. These contain a very low percentage of silica and other impurities. The Coal Measure limestones are but slightly inferior, containing little magnesia, though higher percentages of iron, alumina, and silica. Because of the superior quality of our magnesia limes for building purposes the purer carbonates have been hitherto neglected. There is no reason to doubt that when called for they will be found in ample abundance.

(4) Along the lake shore the supply of pure water is, of course, adequate for any purpose. There are many streams flowing into the lake which would furnish pure water in sufficient quantity for factories, and the same is true of many of the more central regions of the State, while there are but few regions in which a sufficient supply may not be obtained from systems of wells.

(5) In no State in the Union are the farmers better prepared, both by experience and resources, to deal with stock-feeding problems than in Ohio. The practice of purchasing cattle and sheep which have grazed on the Western plains and finishing them on Ohio corn is already a common one, and dairying has long been one of the great industries of the State. Every district has experienced feeders and dairymen who would be ready at once to utilize the refuse of a beet-sugar factory.

(6) Three or more districts stand out prominently in the tests of this season. These are a northwestern district, including Lucas, Fulton, Defiance, Henry, Paulding, Williams, and Wood counties; a northern, including Erie, Huron, Lorain, Ottawa, Sandusky, and Seneca counties; and an eastern, composed of the counties of Ashland, Medina, Summit, Wayne, Holmes, Stark, and Tuscarawas. The number of samples from these districts has been large and the results rather favorable. Scarcely less noteworthy are the results in the counties of Darke, Shelby, Miami, Champaign, and Clark in a western, and Ross County with its neighbors in a southern district. The northwestern district is near natural gas and oil and is accessible to limestone and coal by direct lines of railway. The water supply is believed to be adequate and satisfactory generally. It is certainly so at Toledo.

The northern district is near limestone and water supply and directly accessible to either coal or oil.

The eastern district is near coal and water. It is within easy reach of the pure limestones of Sandusky and Kelleys Island. Limestone from that island is extensively burned at Cleveland.

The data concerning analysis of beets grown this season have been given in our Bulletin No. 90. The following is a summary of the results obtained for different sections of the State and the entire State:

Analysis of beets.

Territory.	Number of samples.		Average weight of beets.	Total solids in juice.	Sucrose in juice.	Purity coefficient.
	Analysed.	In averages.				
			Grams.	*Per cent.*	*Per cent.*	
Southern section	69	67	892	17.0	12.8	75.3
Middle section	146	132	924	17.8	13.9	78.0
Northern section	392	355	834	18.0	14.3	79.4
Entire State	607	554	867	17.8	14.0	78.7

The soils on which these tests were made belong almost exclusively to the glacial drift, which is generally more or less modified by the underlying rock. No general chemical investigation of these soils has yet been made.

OREGON.

Report by Prof. G. W. SHAW, Chemist of State Experiment Station.

Attempts were made in these experiments to secure data both as to the yield and the cost of the crop. In 1891 the average yield reported by eight farmers was 20.5 tons per acre, at a maximum cost of $24.18 per acre; in 1892 the average yield was 23 tons per acre.

The yields and cost per acre for the season of 1897 are as follows for the sections named:

County.	Yield in tons.	Cost.
Washington	15.7	$24.00
Clackamas	17.4	26.00
Jackson	15.8	....
Union	23.4	11.20

These prices do not include rent of land nor cost of delivery to the factory; the latter would probably average about 75 cents per ton, and the former may be estimated as sufficient to raise the average cost to $38 per acre. Thus it would seem that it is not only possible for Oregon to produce beets rich in sugar, but also an excellent yield. In the case of Union County, I believe that it will cost less to raise them than at most other points, as they will require less cultivation than in southern Oregon. I analyzed a sample of beets from there that had received absolutely no cultivation this season, which showed 18 per cent sugar and a purity coefficient of 90, which would indeed be considered excellent in a sample on which the most careful attention had been bestowed.

The beets giving the above yields would have brought $4 per ton, or for the average crop $60 per acre. If we assume, on the basis of the above reports, that the cost will be $38 per acre, there would be a profit of $22, besides a fair rent for the land and good wages for the work, which would be participated in by nearly all members of families, for much of the work can be done by children as well as by men.

FACTORY CONDITIONS.

Let us now turn our attention to the questions of more direct interest to the manufacturer alone.

The counties already named were selected for the work of the past season, because they were, all things considered, typical of the various sections of the State and it was desirable to concentrate the efforts for convenience of work; also because the previous experiments had demonstrated that they could produce most excellent beets.

In any one of these four localities there is ample land for the production of beets for a large factory. Washington County offers a broad expanse of most fertile silt land of great depth. Here it would be possible to grow beets on 20,000 acres of land and not interfere to any great extent with other crops by allowing the beets to take a regular place in rotation where now bare fallow is practiced. From an agricultural standpoint, Clackamas County is so situated as to be able to receive beets from both Yamhill and Marion counties, either of which contains quite as much land suitable for beets as Clackamas itself; and, inasmuch as water transportation here would compete with rail, she would be particularly favored in this respect.

In the matter of the preservation of the beets, however, I fear there would be a serious difficulty. While in either of these counties in the Willamette Valley it is certainly possible to produce beets rich in sugar and with good yield, yet on account of the early fall rains, coming on very soon after the beets mature and in some cases even before maturity, it is very doubtful if the industry would be a reliable one.

Any one of the four localities could furnish an abundant supply of water. There is no question as to the purity of the water in any of the localities, except Union County, and this water was recently analyzed, partially, and showed only 15 grains of solids per gallon. As there are more soluble salts in the soil in this than in any of the other localities, it is probable that the others would show even less than this amount.

Clackamas County, in addition, would have the advantage of unlimited water power which could be utilized. Here the Willamette River pours over a basalt cliff with a vertical fall of 40 feet. At low water these falls give a greater power than those of Holyoke, Lawrence, and Lowell, Mass., Manchester, N. H., and Minneapolis, Minn., combined, and averaged for the entire year.

The average cost of fuel at the various factories now in operation in the United States is $3.50 per ton of coal. The use of wood, coal, and water power in Oregon will give us at least equal if not superior advantages of power and fuel.

Wood must be the principal fuel in either of the four counties mentioned. In the Willamette Valley it could be laid down at a factory at $1.50 to $2 per cord for fir and at a very slight increase for oak, and this could be had in unlimited quantities. In eastern and southern Oregon I think fuel would cost slightly more. High-grade coal will cost us from $6 to $6.50 per ton, but an abundance of wood can be had at $2 per cord at the factory, and thorough tests prove that 1½ cords of wood will develop more energy than a ton of high-grade coal. Millions of acres in the Blue Mountains are heavily timbered, so that the wood supply would not be exhausted during the next century, which assures cheap fuel for a factory.

The cost of limestone is an important factor. In southern and eastern Oregon the price of lime rock would not exceed $2 per ton and might be even less. In the Willamette Valley it would be from $3.50 to $4. The Huntington limestone, which would be used in any factory located in the eastern part of the State, is exceptionally good, carrying less than 5 per cent of insoluble matter, and there are mountains of it. There are no analyses of the southern Oregon limestone at hand, but specimens which I have examined show it to be of pure quality and it can be had in unlimited quantity.

Transportation facilities are about the same here as elsewhere on this coast. In the eastern part of the State the railroad company is inclined to be very liberal toward such undertakings, and has already entered into contract with the Union County people to deliver beets at the factory at a very low rate.

In connection with this phase of the question, the market may be mentioned as including Oregon, Washington, Idaho, Montana, and Alaska, all of which will probably use not far from 50,000,000 pounds of sugar per annum, and this market is essentially local.

PENNSYLVANIA.

Report by Frank C. Bosler, Special Agent of State Experiment Station.

ADVANTAGES AND MARKETS.

The Cumberland Valley offers an admirable location for a sugar factory. Carefully gathered facts show that Harrisburg, located at one end of the valley, is the distributing point for the country included within a radius of 75 miles. The four wholesale grocers of Harrisburg distributed last year 11,000,000 pounds of sugar, and it is estimated that Philadelphia firms sold about 4,000,000 pounds in the same country. Hagerstown, at the other end of the valley, distributes over 3,000,000 pounds through the three wholesale grocers there. Baltimore firms sell in the same country probably 1,000,000 pounds. This makes a total of over 19,000,000 pounds of sugar distributed yearly in the country tributary to the local grocers of the Cumberland Valley. Two competing railroads extend the length of the valley and offer low freight rates to the trade centers and distributing points mentioned above. We have direct shipping connections with all points on three great railroad systems—the Pennsylvania, the Baltimore and Ohio, and the Reading. Fuel can be obtained here at low prices. At Hagerstown the local railroads draw from the coal fields of West Virginia and Cumberland, and at Harrisburg the coal is drawn from the central parts of Pennsylvania. The result is that at the present time soft coal of good quality can be laid down in Carlisle at from $2.10 to $2.15 per ton. Petroleum is not now used in the valley for fuel, but could be brought here at a low rate.

LIMESTONE AND WATER.

Limestone is in great abundance at all points in the valley. It can be bought at the quarries at 25 cents per perch.

Water is in abundance, but that from the two creeks is hard and may not be very suitable for sugar making. In the mountains, however, water with no impurities can be obtained. At a point 6 miles from Carlisle, Mount Holly, a large stream comes down the mountains. This is used by the paper mills located there and will afford an ample supply of water good for manufacturing purposes.

Many cattle are fed in this valley. These are mostly brought from the South, Virginia and West Virginia supplying great numbers every year. Each farm barn has room for from 6 to 40 head of cattle for feeding. The dairying interests are increasing yearly. Many creameries are now in operation. Besides the fresh milk consumed locally in the towns in the valley, there are good opportunities offered now by the railroads for the shipping of milk to the markets of Philadelphia. This trade is growing in favor with the farmers along the lines of railroads. All of these interests will afford a market for the beet pulp.

In the Cumberland Valley and surrounding country great interest is taken in the sugar business. In the counties of Franklin, Cumberland, Adams, and Dauphin a very active and energetic organized effort is being made to determine definitely whether the community offers a favorable opportunity to produce sugar from beets. Many high-grade beets have been grown in the past, as the analyses show, and the coming season will see many hundreds of plats in these counties. Should the results of these tests prove favorable, it is likely that a plant will be erected to work up beets. Labor is cheap and abundant in the locality.

SOUTH DAKOTA.

Report by J. H. Shepard, Director and Chemist of the State Experiment Station.

The State of South Dakota embraces a variety of soil and climatic conditions. One would naturally expect that a State extending from east to west for a distance of 380 miles and from north to south 200 miles would present some variety. The Missouri River, which divides the State in half, marks the western limit of the drift. The soil in the eastern part is a drift soil, while on the west of the Missouri River a variety is presented. In the Black Hills the soils are derived from the weathering of the rocks, while other portions west of the Missouri give more or less evidence of a lacustrine origin.

MARKETS.

In addition to the home market this State is in direct communication with St. Paul, Minneapolis, Chicago, Sioux City, and Omaha. It would require a short haul only to place the finished sugar in the principal trade centers of the great Northwest.

FUEL.

The soft coal now burned throughout the State is obtained from the coal fields of Iowa, Illinois, and Ohio. The anthracite coal comes from Pennsylvania and the far East. Duluth is the terminus of the water haul for this fuel. The prices at present charged for fuel are high and fictitious, and are controlled by the freight rates charged by the railroad companies. But it must be remembered that there are, comparatively speaking, no manufacturing industries at present in the State. A roller mill here and there, with occasionally a machine shop and a few steam-heating plants, are the principal consumers of soft coal in the eastern portion of the State. With the advent of sugar factories the State would thoroughly utilize the immense lignite coal beds lying along the Missouri River in North Dakota. This coal could be distributed at all of the Missouri River points for distribution at simply a nominal cost of transportation for floating it down the river on flatboats. In addition to this, there is no doubt but the railroad companies would be able to furnish fuel in large quantities for beet-sugar factories at very low rates for transportation, bringing it from the Iowa coal fields. The Black Hills region has lignite coal beds, and, as it also lies close to the Wyoming coal fields, fuel is cheap.

LIMESTONE.

The eastern part of South Dakota lies close to the limestone beds of Minnesota. In the Black Hills region immense deposits of the purest limestone are found. What this State needs is railroad transportation between the Black Hills and the eastern portion.

WATER.

All portions of this State are well supplied with water for sugar-factory purposes. In the eastern part, as previously mentioned, nearly all streams have an underflow. This underflow is a never-failing source of water supply, which would be well adapted for diffusion battery purposes. Any of the flowing streams would furnish ample water for washing. The nature of the water from the underflow is shown by the following analysis from a well in the Big Sioux Valley.

Shepard well (from underflow).

Salts.	Parts per 1000.
Sodium chloride, NaCl	0.0098
Sodium sulphate, Na_2SO_4	.1456
Magnesium sulphate, $MgSO_4$	.4311
Magnesium carbonate, $MgCO_3$	.0147
Calcium carbonate, $CaCO_3$	.3427
Silica, SiO_2	.0408
Total	.9847
Total solids by evaporation	.9656

In the James River Valley the artesian wells would not only furnish power but also water for all purposes. The Whiting well, at Yankton, the analysis of which is appended, has a closed pressure of 49 pounds to the square inch, and, although a small well, furnishes from 300 to 400 gallons per minute.

Yankton (Whiting) well.

Salts.	Parts per 1000.
Sodium chloride, NaCl	0.1643
Sodium sulphate, Na_2SO_4	.1172
Magnesium sulphate, $MgSO_4$	.3160
Calcium sulphate, $CaSO_4$	.8700
Calcium carbonate, $CaCO_3$	.1246
Silica, SiO_2	.0070
Ferric oxide, Fe_2O_3	.0032
Total salts	1.6023
Total solids by evaporation	1.6062

The Huron well has a closed pressure of 165 pounds to the square inch, and a flow of 2,250 gallons per minute. This well is supposed to be capable of developing 100-horsepower. The analysis follows:

Huron (Risdon) well.

Salts.	Parts per 1000.
Sodium chloride, NaCl	0.2046
Sodium sulphate, Na_2SO_4	.0683
Magnesium sulphate, $MgSO_4$	.4261
Calcium sulphate, $CaSO_4$	.0020
Calcium carbonate, $CaCO_3$	.1554
Ferric oxide, Fe_2O_3	.0290
Silica, SiO_2	.0080
Total salts	2.0334
Total solids by evaporation	2.0328

For further information the reader is respectfully referred to Bulletins 41 and 49 of the South Dakota State Experiment Station.

As before mentioned, the Black Hills is abundantly supplied with water. No analysis of these waters, however, is at hand.

In regard to the effect of the salts shown by the analyses of the foregoing waters upon sugar solutions, according to A. Marschall and La Grange (Manual of Sugar Analysis, Tucker, p. 69, et seq.), it seems that sodium chloride and sodium carbonate exert no mellassigenic effect. Magnesium sulphate is an actual aid to crystallization. Sodium sulphate probably does prevent small quantities of sugar from crystallizing, while the action of the lime ought to be indifferent.

STOCK FEEDING, ETC.

Perhaps no State is so well situated as South Dakota for stock-feeding purposes. Located as it is in the center of the great grain-producing belt, and blessed as it is with its wondrous wealth of native grasses, and capable of producing an immense supply of corn, root crops, and other coarse foliage crops, it is ideally situated. Moreover, it is within easy reach of the large ranges farther west, and is raising sufficient small grains to feed more stock than the State now produces. But its own range regions are by no means pushed to their full capacities, and as a consequence thousands of acres are lying idle.

Dairying is rapidly increasing its interests in this State. Upward of 145 creameries are now in active operation and more are constantly building. The beet pulp furnished by factories would be a welcome addition for fall and winter feeding, as it would supplement the vast amount of grain crops annually produced.

NATURAL FACILITIES.

The rainfall for the eastern portion of the State is usually sufficient to raise fine crops of sugar beets without irrigation. This rain is in the early spring and during the growing season. In the James River Valley and other sections irrigation may be practiced if necessary. Dakota has been rightly called "The land of sunshine," and it possesses the desirable climatic feature of having little or no rainfall during the ripening period of the sugar beet. In the warm sunshiny days and the cool nights there is very little danger of a second growth in the fall. At the same time the roads all through the State are in the best possible condition for hauling heavy loads. This feature will certainly become a potent factor in delivering sugar beets from a distance to the factory. And then again, the vast stores of plant food in the vast tracts of virgin soil and the great ease with which that soil can be cultivated will certainly be alluring inducements to the sugar-beet industry.

SOILS.

In that portion of South Dakota lying east of the Missouri River there is a greater uniformity of soils than one would expect. In the northern portion of the State there are relatively larger amounts of clay, but over nearly the whole region the soil is a sandy loam. In most localities a yellow-clay subsoil is found carrying large amounts of marl. The present configuration is largely due to the erosive action of water, consequently on the highlands the soil is thinner, averaging from 9 to 14 inches. Below this to about a similar depth is a mixed soil, consisting of portions of the black surface soil intermixed with clay. Beyond this depth the yellow-clay subsoil proper begins.

At a comparatively recent geological time an extension of the Wessington Hills toward the east, or some similar agency, created a gorge in the James River Valley, thus forming a lake which extended from the southern part of Beadle County to the extreme northern part of the State and from the highlands on the east to the range of hills on the west; consequently a large portion of the Upper James River Valley region was once a lake bed, occupied by Lake Dakota. The eastern and western shores were bluffy and steep, but the northern and southern limits were shallow. Near the center of the lake the deposit was rich in clay and silt, while the northern and southern shores were more sandy. On the eastern and western shores this sandy belt was narrower, owing to the abruptness of the hills, which were formerly terminal moraines of great glaciers. It is from these moraines that the soils of the Upper James River Valley were derived. From the southern part of Beadle County following down to the Missouri bottom there has been a gradual erosion, consequently artesian waters are found at a small depth. Along the Missouri River the loess formation exists.

EXPERIMENTS WITH SUGAR BEETS FOR 1897.

The United States Department of Agriculture furnished this station 500 pounds of sugar-beet seeds of the original Kleinwanzlebener variety. This seed was distributed to 954 farmers, residing in 59 counties. Instructions for cultivating the beets were sent with each sample, directing the experimenter to plow his ground 12 inches deep; to firm and fine his seed bed; to sow the beets in 9 rows, 22 inches apart, and covering 4 square rods. He was instructed to sow the seed the last week in April or the first week in May. He was also instructed to thin the beets to from 2 to 4 inches, and to keep the ground well cultivated. It was necessary to plow these plats in the spring. In many places the ground was trashy, and as a subsequent effect proved to be badly infested by cutworms. The land should have been prepared and kept clean the preceding fall.

Of these 954 experimenters, 140, or about 15 per cent, reported failures. In some instances this was partly due to a heavy frost on the night of the 24th of May and partly due to the action of cutworms. The thermometer fell to 27° over some portions of the State at that time, and some of the plants which were in a very tender stage just then were killed; some that were further along simply lost their leaves and grew again, while others that were just breaking through the ground were not injured at all. Others of these 140 failures were due to a failure of the seed to germinate, because the seed beds were not firmed. Still others were destroyed by stock. There are very few fences in South Dakota.

Four hundred and thirty-four, or about 45 per cent, of the experimenters did not report at all. Some pains were taken in several counties where movements were on foot to erect sugar factories to ascertain the reasons why these delinquents did not report. It was found that it was mostly due to carelessness, although a few had failures.

Three hundred and eighty experimenters, or about 40 per cent, sent in samples for analysis. These samples came from 51 counties.

Of the 380 samples received 37 were rejected at this station because the experimenters disobeyed instructions. Some of these plowed the ground only 4 inches deep. One man simply disked it. These beets grew above ground and were deformed, coarse, and necky. Some planted the seeds in one row; others planted the rows too wide, and others gave the beets little or no cultivation. When it was ascertained at this station that cutworms were working on the plats circulars were sent out advising the experimenters to transplant a few of the beets around three or four which were growing close together in order to procure a sample for analysis. Some failed to do this and left their beets growing several feet apart. Others sent in poor samples.

Of the 37 samples which were rejected, however, 13 gave over 12 per cent sugar in the juice. The highest rejected sample gave 18.3 per cent sugar in the juice. This man sowed his seeds all in one row. The lowest rejected sample gave 8.8 per cent sugar in the juice. This man mulched his beets with hen manure and raised 38 tons per acre.

Fearing that some plats were planted late, and owing to the fact that it was impossible to collect preliminary samples from such widely scattered regions, notices for harvesting the beets and taking samples were not sent out until about the middle of October. This was thought to be preferable in order that any late sown plats might reach maturity. There was little danger of a second growth starting for reasons elsewhere stated. Some of the experimenters became uneasy and harvested their plats before directions had reached them; consequently, these could give no tonnage per acre, except in a few cases, where the whole crop was weighed.

VALUE OF THE TESTS MADE IN 1897.

From some of the foregoing considerations it will be seen that many reasons exist why the tests thus made did not actually represent the capacity of the soil and climate of South Dakota. A personal inspection of many of the sugar-beet plats in various parts of the State revealed the fact that the beets were grown under the poorest possible conditions. A large number of the experimenters utterly failed to grasp the correct conception of what is necessary to the highest development of the sugar beet. For instance, some planted in rows as wide as 8 feet apart; again, others planted in rows from 3 to 4 feet apart, and when the fact was called to their attention that their beets would grow too large, they endeavored to compensate by crowding them in the rows. This was certainly not an ideal condition. Again, others allowed their beets to grow up and struggle with weeds as best they could. In short, it would be safe to say that the majority of all the samples grown would have done better had better care been given them. Many of the samples had been carelessly dug. Some of the beets in very many samples were broken in two and the lower half in numerous instances was missing.

UTAH.

Report by LUTHER FOSTER, Director of the State Experiment Station.

MARKETS.

In the matter of favorable location and facilities for marketing the sugar product, Utah is not excelled or even equaled by any other State in the West. This State is the natural commercial center of the whole mining region of the Rocky Mountains. It has direct railway connections with nearly all of the intermountain States by which our products are carried to all of the great mining centers of the western United States. The outlet to the north and northwest is especially good, connecting by direct routes with the Northern Pacific and Great Northern railways, thus reaching very directly, through these and the Oregon Short Line, all of the principal distributing points in Idaho, Montana, Oregon, Washington, and Wyoming, in addition to portions of Canada. The above possibilities of marketing are, aside from the large home consumption, constantly increasing through the extension and development of the fruit industry. It is estimated that it will require the whole product of the Lehi factory and that recently organized at Ogden to supply the amount consumed in the State.

FUEL.

Soft coal is the main reliance for fuel in this State, and it is within easy reach of all places where factories are likely to be located. While there is an abundance in the State, the principal mines being located near its center, much of the supply at present for the northern portion comes from Wyoming, the location of the mines being more convenient. A good quality of nut coal in small quantities can be had in any portion of the State at $4 per ton; and I am informed that in large quantities, such as a factory would require, it can be obtained for $3.

PURE LIMESTONE.

This is an abundant article all over Utah, and a factory located in any part where the cultivated area is large enough to support it would be in the neighborhood of extensive limestone formations where granular or crystalline limestone is plentiful.

THE WATER SUPPLY.

With few exceptions, sugar beets can be grown successfully for factory purposes under a system of irrigation only, and wherever the water supply is large enough to grow an acreage sufficient to run a factory it would be abundant for factory purposes, since it would not be required for that purpose until the irrigating season had passed. It is estimated that a factory of 350 tons capacity requires about 1,500,000 gallons of water daily, and this is but little more than is required for the proper irrigation of 200 acres of sugar beets. The water available for factories anywhere in the State would come from mountain streams, insuring a quality unexcelled.

STOCK FEEDING.

The most profitable use to be made of beet pulp is, no doubt, for milk production. Dairies are at present so well distributed over the State that future factories must be located in the midst of dairy districts. The State is well prepared, with its million and a half of sheep and its 200,000 cattle, to make speedy and profitable use of all pulp not utilized by the dairies.

The dairy business has made rapid and continuous growth since its beginning a few years ago. There are at present 33 creameries and cheese factories in operation, with indications of a still wider extension of the work. For this line of products markets and prospects are good.

UTAH CONDITIONS SUITED TO THIS INDUSTRY.

The Utah farmer, as a rule, owns but a small piece of land, ranging from 5 to 40 acres. Since successful beet culture requires intensive farming, these small holdings are exactly suited to such work. There are few other crops for which the control of the water supply is so important. The maturity, and hence quality, of the crop must depend largely on having plenty of moisture at the right time for growth, and then having it withheld at a suitable season to insure no loss from the second growth so often induced by fall rains in a humid climate, and to give ample time for complete maturity. Under a system of irrigation like Utah's, not only more perfect maturity is obtained, but more time may be secured for the harvest, making it possible to handle a greater acreage without additional help. Beets and other root crops endure a low temperature in our dry soils, a degree of cold that would prove destructive in a moist climate.

WASHINGTON.

Report by Elton Fulmer, Chemist of State Agricultural Experiment Station.

That the State of Washington has a great future in the production of sugar from beets seems to be a conclusion fully warranted by the experimental results that have been obtained during the past four years. These experiments have been more extended and more systematic in this State than in any other section of the Pacific Northwest. We believe it is not an exaggeration to say that no other State in the Union has carried the sugar-beet experimentation from the simple standpoint of character and culture conditions so far as it has been carried here. In the main, this work has been under the direct supervision of the chemical department of the experiment station. The work of the first year was a series of cooperative tests in which results were obtained from 101 different localities in the State. The average of 1,544 analyses made during this year (1894) were as follows: Weight, 22 ounces; sugar in juice, 15.2 per cent; purity coefficient, 83.8. When we take into consideration that these results include all samples, good, bad, and indifferent, mature and immature, large and small, it must be conceded that the above averages are exceptionally good. Furthermore, when we consider that the samples were selected for analysis by 384 different men, none of whom were informed as to the characteristics exhibited by a sugar beet rich in saccharine matter, it becomes evident why we considered the results sufficiently favorable to warrant a further extension of the work. For the work of the next year (1895) the legislature made an appropriation of $1,500, with which a series of experiments were carried out with acre tracts, the object being a determination of the yield per acre and cost of production. A set of meteorological instruments was placed at each point where the tracts were raised, in order to ascertain the temperature and rainfall conditions under which the beets were grown. When the beets were mature, 50 average samples were selected from each tract and analyzed, with the following results:

Analysis of beets.

Locality.	Average weight.	Average sugar in juice.	Average sugar in beet.	Purity coefficient.
	Ounces.	*Per cent.*	*Per cent.*	
Puyallup	17.0	18.0	17.1	89.1
Chehalis	23.5	17.2	16.4	85.1
Ellensburg	14.0	18.0	17.1	88.2
Hartford	12.0	17.9	17.0	88.8
Nooksachk	19.0	16.4	15.6	89.1
Dayton	11.0	14.3	13.6	81.3
Vancouver	34.0	15.0	14.2	87.2
Orting	18.0	17.7	16.8	92.7
Waverly	17.0	19.5	18.5	89.4
Crescent	8.0	16.6	15.8	87.8

QUALITY OF BEETS, COST OF RAISING, SUGAR CONTENT.

Many very interesting and important facts were learned as the outcome of this year's work. It was clearly demonstrated that beets of a very superior quality could be grown in acre tracts as well as on small experimental tracts. It was further shown that the cost per acre of raising sugar beets on a commercial scale in this State will not exceed $30. The actual weight of the beets grown on these experimental acres and data obtained from other sources warrant the statement that from 18 to 20 tons per acre is a conservative estimate of the yield that may be expected in an ordinary season. A comparison of the sugar content and purity of the samples analyzed, with their weight, reveal the fact that the size of the beet has but little influence upon the sugar content and purity of those grown in this State. It was further found that no serious difficulty occurs from second growth, and that, in general, Washington beets are not easily susceptible to abnormal climatic conditions. These facts are fully discussed in Bulletin 26 of this station.

PRODUCTION OF HOME-GROWN SEED.

A number of experiments have also been carried out in the production of home-grown seed, all of which seem to indicate that Washington can produce seed of high grade. A number of half-acre tracts have been raised from this home-grown seed, and in almost all instances the sugar content and purity were higher than in the samples raised from imported seed. During the year 1897 a series of experiments were carried out in the Yakima Valley in raising sugar beets by irrigation. We give below the averages obtained from the analyses of eight samples and the yield per acre, as determined by weighing the beets harvested from a given length of row:

Name of grower.	Variety.	Yield per acre.	
		Tons.	Pounds.
E. Remy	Kleinwanzlebener	19	332
J. W. Young	Vilmorin	32	585
Do	Kleinwanzlebener	28	192
H. E. Linse	do	27	885
J. A. Berg	do	17	840
W. N. Granger	do	32	498
W. H. Norman	do	27	450
H. D. Winchester	do	21	1,560

Average weight	ounces	24
Average sugar in beets	per cent	16.7
Average sugar in juice	do	17.6
Average purity coefficient		85

Any comment upon these figures is unnecessary. They speak for themselves concerning the possibilities of beet-sugar production in our irrigated districts.

CAUSES OF POOR RESULTS IN EXPERIMENTS OF 1897.

In the fall of 1897 a number of samples were analyzed, which were raised from seed furnished by the Department of Agriculture, Washington, D. C. The results they yielded were so wholly at variance with all previous results that we do not consider them as at all representative of the beets that can be raised in Washington. We explain the poor results as due to several causes: First, to too late planting; second, to the fact that many of the localities in which the beets were raised have not hitherto shown any special adaptability to beet culture; third, the indications are that the seed furnished was mixed and not of high grade, because the samples raised from it clearly exhibited the characteristics of several distinct varieties; and, fourth, the samples raised in Lincoln County, which has always heretofore raised beets of an excellent quality, were greatly inferior to the samples raised on the same land from home-grown seed.

FACTORY REQUIREMENTS.

The detailed results of all of our work have been published in Bulletins 15, 26, and 31, to which we would call attention in this connection. There seems left no room for doubt as to the ability of Washington to produce high-grade beets having a satisfactory tonnage yield, and at a cost per acre which will render them a profitable crop for the farmer to raise. At the same time, we have in the State all of the factory requirements for the successful conduct of the beet-sugar industry. The requirements of a factory are, first, a large amount of comparatively cheap fuel, plenty of pure limestone, and an abundance of pure water; not only this, but there should also be good facilities for transportation; also, important trade centers and a good market for the sugar produced. It is further desirable that the refuse pulp from the factory should be in demand for stock feeding. All of these conditions are fully met in the State of Washington.

First, let us consider the question of transportation and markets. A study of the natural conditions and the exhaustive experiments that have been made warrant the statement that beet sugar can be produced in Washington at as low a cost as anywhere else in the United States. This being the case, the market for the sugar produced is limited solely by the cost of distribution.

The present sources of supply of the sugar consumed in the entire Pacific Northwest are Hawaii, China, and the sugar-beet factories of California, with San Francisco as the distributing center. Factories located in Washington east of the Cascade Mountains would have a decided advantage over the present sources of supply in that large territory between the Cascade Mountains and the Missouri River, comprising all or a considerable portion of Washington, Oregon, Idaho, Montana, Wyoming, Dakota, and British Columbia and the Northwest Territory. Factories located in central or western Washington could compete successfully with San Francisco for the trade of the district west of the Cascade Mountains, comprising the Lower Columbia River Valley and the Puget Sound basin; also for the rapidly growing trade of Alaska. We have not overlooked the fact that all shipments of sugar from San Francisco to the distributing points—Portland, Tacoma, Seattle, Victoria, and Vancouver—is by water, at low rates of freight; but from a factory located in western Washington or in the Yakima Valley, in central Washington, the rail haul to coast points would be short and the railroads would follow their invariable rule of making rates that would meet water competition.

Washington is particularly fortunate in its abundant railroad facilities, in this respect being superior to any of the other States on the coast. Two transcontinental lines—the Northern Pacific and the Great Northern—parallel each other across the entire State, with branch lines in all directions. The Oregon Railway and Navigation Company crosses the southern portion of the State and forms, with its connecting line, the Union Pacific, a third transcontinental line, while the Canadian Pacific, paralleling the State on the north in British Columbia, affords an opportunity to reach directly all points in the Canadian northwest.

We estimate the population in the territory that would be exclusively tributary to Washington factories at 2,000,000, which, multiplied by the per capita consumption of 65 pounds, gives a requirement of 65,000 tons of sugar per year, equal to the product of 13 factories, each having a daily capacity of 400 tons of beets.

FUEL, SOIL, AND WATER.

This State has an abundant fuel supply, both of wood and coal. There are several productive coal mines in the western portion of the State, and coal can be laid down at any point in eastern Washington for factory purposes at a price that would not be in any way prohibitive.

In Stevens County, as well as in other sections of the State, there are immense deposits of very pure limestone. Samples of the Stevens County limestone analyzed in our laboratories were 98 per cent calcium carbonate. This deposit of limestone would be easily available for any factory located in eastern Washington, while that found in San Juan County could furnish all that would be required by factories located west of the Cascade Mountains.

In all sections of the State which have shown marked adaptability to beet culture there is an abundant supply of pure water that can be used for factory purposes.

STOCK FEEDING IN CONNECTION WITH FACTORY.

Concerning stock feeding in connection with a factory, Prof. W. J. Spillman, agriculturist of the experiment station, says the following: "The digestible constituents of sugar-beet pulp are practically identical with those of the carrot. The latter is so much prized by the dairymen of the State that they buy them at prices far in excess of what their digestible ingredients would seem to justify. There are many sections of the State where large quantities of such a feed would find ready sale at reasonable prices, especially in the vicinity of each of the three largest cities and in the Yakima and Kittitas valleys. Within a radius of 20 miles of Spokane alone there are probably 15,000 cows for which more or less feed is bought, and practically all of these could be depended upon as consumers of the waste from a beet-sugar factory. This material can be placed in silos, and thus its period of usefulness can be greatly extended beyond the beet-sugar campaign. The dry pulp contains about the same digestible constituents as wheat grains, and hence would be a desirable feeding stuff, especially for beef cattle. It would also be much fed to dairy cows.

"The amount of live stock in this State is already quite large, and under the stimulus of a cheap and valuable feed would undoubtedly largely increase. The farmers of the State are, as a rule, quick to take advantage of anything that gives promise of improving their condition, and I am of the opinion that a sugar factory would find little trouble in disposing of all it could produce of a feeding stuff which could sell a little below the cost of other feeding stuffs of similar value."

The dairy industry is now pretty well developed in this State in the Yakima and Kittitas valleys, and in the vicinity of Spokane, in eastern Washington.

The analyses of nearly 100 samples of soil from various portions of the State only show what practical agricultural experience has already demonstrated, that the soils of Washington are exceedingly rich in the essential elements of plant food. A few of these analyses have been published in Bulletin 13, of this station. About 60 more are now in manuscript form, and will be published in the near future.

The investigations that have been carried on in this State in connection with the sugar-beet industry have been very varied in character, and the entire subject has been viewed from every standpoint. It is impossible to give in the brief limits of this report anything more than a mere outline of the work and a simple statement of the conclusions that have been reached. For full details we beg leave to refer you to Bulletins 15, 26, and 31, of this station, to which reference has already been made.

In conclusion, we will simply state that the natural conditions and resources of this State are perhaps more favorable to the successful establishment of the beet-sugar industry than those found in any other section of the Pacific Northwest.

SUGGESTIVE STATISTICS.

Willet and Gray's Journal offers some very interesting statistics as to the consumption of sugar in this country in the year 1897, which give us some idea of the total amount of sugar consumed and the relation that exists in this consumption between beet and cane sugar.

Amount of sugar consumed in the United States in 1897.

		Tons.
Domestic cane sugar		289,009
Domestic beet sugar		41,347
Maple sugar		5,000
Sorghum sugar		300
Total consumption of domestic sugar		335,656
Foreign cane sugar		1,066,684
Foreign raw beet sugar		616,635
Foreign refined beet sugar		77,288
Total consumption foreign sugar		1,760,607
Total consumption of sugars of all kinds		2,096,263
The United States in 1897 produced of sugar beets	tons	389,385
Land required to produce these beets	acres	41,233
Average yield per acre	tons	9.5
Total amount of beet sugar made in the country during the year	do	45,245
Average yield of sugar of each ton of beets	pounds	233
Average of sugar secured from the beet and based on its crude weight, per cent		11.6
Each acre produced, on an average, of sugar	pounds	2,204

The Sugar Beet, from official reports received, states that the cost of making sugar in Germany is about $6 for every ton (of 2,240 pounds) of beets worked. From the same source it is learned that experts in Austria-Hungary have been compiling statistics on the cost of producing sugar in the United States, and for each ton (2,000) of beets they divide the cost as follows:

Fuel	$0.27
Labor	.65
Coke and laboratory	.75
Beets	4.00
Other expenses for beets	.33
Total	6.00

They then use the average number of tons of beets required to make a ton of sugar as a factor, and multiply $6 by this in order to get the cost of making a ton of sugar. In this way they estimate the cost of making sugar at 3¼ cents per pound and assume the selling price to be 5½ cents, which gives a profit of 2¼ cents per pound.

Sugar-beet growers are always interested in getting as much data as possible as to the facts of experience in other places touching the tonnage per acre and the amount of sugar produced per acre. These give an indication of what might be expected of their own land in this direction. Here are some data along that line:

No. 1. It is generally claimed that a ton of beets will produce, in sugar..pounds..	230
No. 2. This country averaged last year in sugar per ton of beets....pounds..	232
No. 3. Some of the best factories in Germany and France have produced from a ton of beets.....pounds..	240
No. 4. Louisiana last year produced of sugar per ton of cane..........do....	161

If the average yield of beets were 12 tons per acre, which is not far out of the way in this country when conditions are right, the same being true of Germany, though the yield is somewhat less in France, we would then have the following:

No. 1. An acre would produce (230 multiplied by 12) 2,760 pounds of sugar; this selling at 5 cents a pound would yield......................	$138.00
No. 2. In this country an acre produced last year (232 multiplied by 12) 2,784 pounds; this at 5 cents a pound would yield	139.20
No. 3. The best factories in Germany and France produced (240 multiplied by 12) 2,880 pounds of sugar; this at 5 cents a pound would yield.	144.00
No. 4. The cane-sugar factories of Louisiana (the average yield of cane being 16 tons per acre) last year produced (161 multiplied by 16) 2,576 pounds of sugar per acre; this at 5 cents per pound would yield.......	128.80

DESCRIPTION OF THE PROCESS OF MANUFACTURING SUGAR FROM BEETS.

It was found, from questions frequently asked during the investigation, that the public was interested in the process of manufacturing sugar; and thinking it would be well to include in this report a plain description of the process, I asked Mr. G. S. Dyer, technical superintendent of the beet-sugar factory of Los Alamitos, Cal., to prepare a paper on the subject, at the same time asking him to make it as free from technical terms as possible. In response to this request Mr. Dyer has kindly furnished an interesting statement, in transmitting which he says:

> Inclosed find the matter for which you wrote some few weeks ago. I trust that I have covered the ground to your satisfaction. In justice to myself, please note that I have not made my remarks technical, and for that reason I may be criticised as to their accuracy. If I should be, I would be pleased to explain any point more fully.

Mr. Dyer has not only had an extended experience in the manufacture of sugar in this country, but has spent several years in Europe in the investigation of the subject, and his paper, which follows, is therefore entitled to consideration:

THE MANUFACTURE OF BEET SUGAR.

By G. S. DYER.

The beets after reaching maturity are loosened from the soil by means of special plows, topped with one stroke of the knife at a point that is marked by the lower circle of dried leaves, and thrown into wagons by using a fork similar to a charcoal fork. This wagon load of beets, on reaching the factory site, is first weighed and is then driven up an inclined bridge that reaches the dumping platform of the beet sheds. A chain attached to one side of the platform is then connected with the body of the wagon to prevent the wagon from sliding off the platform when being dumped. The side board opposite is then lowered and the man in charge, by turning a crank, which acts on levers by means of a wire rope, causes the platform to partially invert, with the result that the beets fall into the bins below. At the bottom of these bins is a covered concrete flume about 18 inches deep and 14 inches wide. When these covers, about 2 feet long, are removed, the beets fall into the flume and are carried along by a swift current of water to the factory.

WASHING AND SLICING THE BEETS.

The first process on arriving at the factory proper is a purely mechanical one and is called the washing. By this adhering particles of dirt and leaves (called tare) are separated from the beets in a specially devised apparatus that keeps the beets agitated in a flow of clean pure water. The washer is about 10 feet long and 3 feet deep, and has a shaft running through the center, to which are attached about a dozen arms.

The clean beets overflow into iron buckets attached to an elevator chain, which delivers them to the slicer on the third floor, where they are cut up into small strips about 2 inches long, one-fourth inch wide, and one-sixteenth inch thick, called from the French "cossettes." The cutter consists of a rapidly revolving disk about 3 feet in diameter, in which are placed sets of special knives, so arranged that on every revolution a great number of cossettes are sliced off the beets that are immediately above.

The cossettes are collected by means of a chute directly under the cutter or slicer, down which they slide into the cell of the diffusion battery. This chute is so constructed that it can easily be moved from one cell to another by a series of small rollers at the top—hanging on a swivel, as it were.

THE DIFFUSION BATTERY.

The diffusion battery consists of fourteen cells, placed in a circle and so connected by pipes that water or juice can flow through one from top to bottom and immediately pass to the next, which it traverses in like manner, and so on throughout the entire circle. At the top and bottom of each cell are doors that are used for filling the vats with the cossettes, and after the sugar is extracted the ones at the bottom are used for emptying out the pulp (exhausted cossettes). The cells are about 10 feet high and 4 feet in diameter, and contain about 2¼ tons of cossettes when filled. The cells are filled and emptied in regular order in conformity with their position in the circle, about eight to ten an hour. Each time a cell is filled a certain quantity of the fresh juice which has traveled the entire circle and has been through this particular cell last is drawn off into the workings of the factory into what is called a measuring tank. This juice has the appearance of black, muddy water, in which flocculent particles are very apparent. The pulp from which the sugar has been extracted is conveyed from the bottom of the battery by means of a helix to a press, where the surplus water is pressed out; thence by cars or otherwise to the silo, where, after it has become sour, it is fed to cattle as desired.

CLARIFICATION.

The charge of juice, after being measured in the measuring tank, is forced through the "calorizators" or heaters to the carbonators. The juice is heated in the calorizators to a temperature of about 190° F., to cause coagulation of the albuminoids. A calorizator has the appearance of a very short ordinary steam boiler, only in this case the juice flows through the tubes and the steam is in the interior. It is about 6 feet long and 5 feet in diameter. This process is the first of the clarification and a very important one.

At the carbonators a quantity of milk of lime, equal in bulk to about one-tenth of the juice therein contained, is allowed to flow in from a small tank situated directly above. This lime forms precipitates with the foreign substances, and the results are precipitated by charging with carbonic-acid gas. These precipitates are removed at the filter presses, of which we will speak further on. The carbonators are nine in number, and are arranged so that each will hold two charges from the measuring tank. Their dimensions are about 12 feet long, 5 feet wide, and 9 feet deep, being supplied on the interior bottom with steam coils and gas injectors. There are two sets of carbonators, called first and second. The operation is the same in both, except that in the second less lime is used and the heating is conducted differently. After the juice has been brought down to a certain degree of alkalinity (a technical term by which is meant the per cent of lime left in the juice) by means of the carbonic-acid gas, it is forced through the filter presses, which remove the precipitates and other mechanical impurities. The presses are made up of about forty frames, hollow on the inside, of about the following dimensions: 3 feet high, 3 feet deep, and 1 inch thick. Between these frames are placed canvas, and the whole arrangement is tightened by using a screw at one end. The turbid juice is forced into the cavities in the frames, and in order to get out it must pass through the cloth, thereby leaving the sediment behind. When a press becomes full of this "scum," as it is called, the press is opened and the scum thrown into a screw conveyor that transports it to a pile in the yard. This is afterwards used for a fertilizer and as a filling for certain pavements. The juice on leaving this stage has a bright amber color. It is then pumped to the sulphuring tanks, where fumes, produced by burning sulphur, are forced into it. The action of the sulphur is mainly a decolorizing one, although some lime is precipitated. The sulphuring is controlled by making tests of the alkalinity and by observing the color. If properly conducted, the juice should have after this operation a close appearance to ordinary water. The tanks are of the same general construction as the carbonators described above. The sulphur-gas generator looks like two iron barrels placed side by side, one being used at a time, the other standing idle or being cleaned as the case may be. Air is pumped into one end by an air pump over the burning sulphur and out at the other through pipes to the tanks of charging.

The juice, after being sulphured, then undergoes another filtering in what are called mechanical filters. These filters are iron boxes about 4 feet square on top and 3 feet deep, and are supplied with a cover for removing the bags, which are on the inside. The action of these filters is just the reverse of pouring a liquid into a bag and having it filter through, for in this case the juice flows from the outside of the bag to the inside and then over and out the top of the filter. The bags are stretched over copper frames to prevent them from collapsing during the operation.

CONCENTRATION.

This process completes the clarification and the juice is then ready to be concentrated, which is done in the evaporating apparatus, called the "quadruple effects." These are four in number, as is signified by the name, and each is composed of two apartments—one for the steam and the other, occupying over two-thirds of the space of the "effect," for the juice and vapors that arise owing to the boiling. The arrangement is such that a vacuum pump that is connected to the condenser of the fourth effect causes a vacuum in each, but of different degrees, so that the juice can be readily drawn from one to the other as desired. Another reason why this process is conducted in a vacuum is to prevent the loss of sugar due to excessive heat. Each effect is about 12 feet long, 11 feet wide, and 10 feet high. A large vapor pipe 20 inches in diameter runs from the top of the first to the steam chest of the second, and in like manner from the second to the third, and so on, uniting them all. The idea of the arrangement is this: The steam turned into the steam chest of the first boils the juice in that effect; the vapor arising from this goes over and boils the juice in the next; and so on until they are all boiling at once. As the juice is concentrated they draw from one to the other to maintain a constant level. When the density of the last is at the required point, the juice is pumped out and to the vacuum pan where it is boiled to grain.

THE VACUUM PAN.

The vacuum pan has the general appearance of a large hollow globe of about 11 feet in diameter, and is made of cast iron put together in segments. The vacuum is caused by a pump considerably augmented by a condenser. The operation of boiling is conducted in the following manner: A vacuum is produced by means of the pump, then the juice is drawn in to a certain level; steam is turned into the copper coils situated in the bottom, causing the juice to boil. When the juice has boiled down to a certain density, small grains of sugar appear. When the grains are of sufficient number in the opinion of the operator, more juice is drawn in. This new lot instead of starting new grains deposits upon the first; the operation from here on is a continual drawing in and boiling down until the pan is full. It is then let out into the mixer by a large valve placed directly in the bottom. The mixer is a large V-shaped trough with a shaft, on which are placed arms in the bottom that keep the "melada" from solidifying. This melada or boiled juice has the appearance of equal parts of sugar and molasses mixed together into a thick paste.

The mixer is about 30 feet long, 10 feet wide at the top, and 7 feet deep. Attached directly below are the centrifugals, eight in number, which receive the melada through short spouts that are controlled by means of a perfectly tight-fitting gate.

THE CENTRIFUGALS.

The centrifugals are of the general appearance of those used in laundries, being supplied with a screen on the side and revolving about 1,000 times per minute. A charge of melada is drawn in the centrifugal of about 200 pounds and the machine set revolving. After about ten minutes the molasses is thrown off and a small spray of water is directed against the sugar adhering to the sides of the machine, which completes the operation, leaving the sugar pure white. This sugar then falls, when the centrifugal is stopped, by means of a trapdoor in the bottom of a machine, on a carrier that takes it to the granulator or dryer, where the slight amount of moisture is driven off, after which it falls down a chute to a hopper, whence it is placed in bags for shipment.

The granulator is a boiler-shaped structure about 30 feet long and 6 feet in diameter, which is slowly revolving. In the interior are steam pipes that cause the heat for the drying. Attached to the interior sides are small shelves that cause the sugar to pass the entire length and not to stay in one part too long, as there would be danger of burning.

Going back to the centrifugals, the molasses that runs off from the melada is collected in tanks for that purpose, and when enough has accumulated it is sent to the vacuum pan and reboiled; but in this case it is not boiled to grain, but simply concentrated as much as is consistent. This operation usually takes two hours, whereas the graining takes about five hours. This "blank melada" is then run into crystallisers that are of the exact capacity as the vacuum pan, where it is kept in a slow, constant motion to promote graining for about three or four days. It is then treated in the centrifugal. The sugar coming from this being very unpalatable, is melted in a special mixer and is pumped back into the thick juice. If on analysis the molasses is found to contain no more available sugar, it is used for sprinkling roads or making vinegar or blacking. But if it contains sugar that will crystallize, it is placed in tanks outside of the building and allowed to stand until the following season, when the sugar that has settled to the bottom is dug out and worked over.

THE CRYSTALLIZERS.

The crystallizers are large, boiler-shaped vessels about 15 feet long and 8 feet in diameter, supplied on the outside with a water jacket to allow of cooling when necessary. On the inside is a shaft with arms, which, turning slowly, gives movement to the entire mass.

Auxiliary to the factory is the limekiln, where lime rock is burned for the resulting lime and gas (carbonic acid). The kiln is about 40 feet high, with walls 2 feet thick, and with a diameter at the base of 15 feet and at the top 8 feet. Being cone shaped, the rock and coke that is put in at the top is not liable to choke during its passage through to the bottom. In the same room the lime is slaked into milk of lime, by an apparatus similar to the granulator described above, and is then pumped to the factory as required by a small centrifugal pump. The steam is furnished by ordinary steam boilers placed in batteries.

A factory of, say, 750 tons capacity would have daily output of sugar equal to about 90 tons of pure granulated sugar, and would require daily 45 tons of lime rock. The number of men engaged in active operation would be about 165.

LABORATORY.

Every well-regulated sugar factory should have a laboratory in connection. where not only are experiments conducted in regard to the cultivation of the beets in the field, but also, by analyzing the different products during the course of manufacture, a complete tabulated chemical control is maintained.

THE ISLAND OF PORTO RICO: ITS INDUSTRIES AND EXPORTS, WITH SPECIAL REVIEW OF THE SUGAR INDUSTRY OF THE ISLAND.

The principal industry of Porto Rico is that of producing sugar from the sugar cane. With a view to adding to the general information concerning the sugar industry, I made a trip to Porto Rico and Cuba in the latter part of the year of 1898, remaining until early spring of 1899. I investigated as closely as possible the cost of producing and transporting sugar and other conditions of the sugar industry in those islands, and especially in Porto Rico.

GENERAL INFORMATION.

The island of Porto Rico is very nearly a rectangle, allowing the outer margins to be broken by a few small capes and bays. Its greatest extent is east and west. In round numbers, it is about 90 miles long and about 40 miles wide. It has on all sides a level, low coast plain, varying from 3 to 10 miles in width. This lowland is composed of cultivated lands and marshes. Through the center of the island extends a chain of mountains which ranges in altitude from highlands to an elevation of 7,000 feet at its highest point. Among these mountains are numerous passes and valleys, and, radiating from them in every direction, streams of fresh water flow into the ocean. These streams vary in size from small creeks to large rivers.

There are a great number of small bays, harbors, and inlets on the coast of the island and quite a number of towns or seaports. Starting west from the capital and circumnavigating the island, these seaports would be reached in the following order: Arecibo, Aguadilla, Mayaguez, Ponce, Guayama, and Humaca, and the town of Isabel, on the small island of Vieque. In addition to these are the inland towns, of which there are quite a number ranging from 1,000 to 6,000 inhabitants. Of these may be mentioned Cayey and Caguas in the tobacco districts, and in the principal coffee districts Yauco and Lares.

The soil of the valleys and the belt around the border is largely made up of a silt formation and disintegrated rocks of mountains washed to these lower levels. The island itself is of a calcareous rock, coral formation, and volcanic upheaval. The island is very fertile and productive, and will grow almost anything that can be grown in the tropical or semitropical regions, and some things belonging to the temperate zone. Doubtless many new plants could be introduced, with proper experimentation in this direction.

The principal exports are coffee, sugar, and tobacco; in fact, these are about all the exports worth mentioning. In addition to these the island carries on a small trade with adjacent islands in hides and cattle. Besides this, it produces readily cocoanuts, oranges, and several other fruits peculiar to the Tropics. The cocoa bean is grown to an extent sufficient to indicate that it would do well. Vanilla is also produced in a small way.

The island has some of the best and some of the poorest roads to be seen anywhere. The military roads are of fine design, carefully made of macadam, and nicely kept. The general trend of the military roads is around the coast through the lowland, with one or two cross roads connecting the north and the south coasts. All other roads are very poor and almost impassable on account of the frequent rains and total lack of care. There are a few railroads, connecting the principal points. These are all of the narrow-gauge order, and very small at that. In addition to these, some large sugar plantations have railroads or tramways, connecting their factories with their estates, with auxiliary portable sections extended into the fields, the object being to bring in the cane to the factory and to take the product to the nearest military road or railroad. These factory railroads have small freight cars propelled either by steam or oxen. All animal draft work is done by oxen. These animals are of a Spanish breed, rather small, compact, strong, and on the whole may be classed as good draft oxen. There is an entire absence of horses or mules of the kind suitable for doing draft work. The yoke for oxen is fastened on the front of the head and attached to the horns. The ox propels the load by pushing it with his head instead of having bows that go around the neck, throwing the draft on the shoulders.

The rents of the better class of lands range from about $4 to $6 per acre in United States money.

Taxes under the new order of Governor Henry are based on the grade of the lands, which are divided into first, second, and third class. The first grade is taxed $1, the second 50 cents, the third 25 cents per acre in Spanish money, $1 in Spanish being equal to 60 cents in our money. The values of these lands at the present time, as estimated by the owners, stimulated by their high ideas of the effect of American occupation, are very high; in fact, very much above what the facts justify. They ask from $100 to $200 Spanish money for the first-class lands.

Their methods of work and the habits of these people are, as a rule, very primitive. They accomplish nothing like the results attained by laborers at the same kind of work in our own country. I think one of our laborers would do as much as three. Their implements of all kinds are primitive and out of date. Their methods of doing things are faulty and in accord with the instruments of execution. When we consider the nature and fertility of the island and its diversity of resources, it seems remarkable that they have but one forage plant on the island. This is a succulent, coarse grass, corresponding very closely to our orchard grass, which they call "malogillo." This is cut and bound up green, like bundles of oats, in which shape it goes into the markets. It is never cured; in fact they claim they can not cure it. All the animals on the island, including the work oxen, riding ponies, and milch cows, get this grass for their food ration, and nothing else unless it is imported. No grains of any kind are raised or fed. Yet the draft ox is expected to do very heavy work. As to whether other things can be grown that will increase the animal bill of fare, the future must tell.

In this connection it may be worth while to mention the food rations of the people, as it has a bearing on their industries. The results to be attained by labor, whether animal or human, can be largely estimated from the food consumed. It would be as unreasonable to expect good results from either on limited, poor, and sometimes innutritious food as to expect a maximum of energy from a steam engine supplied with a poor kind of fuel.

Over one-half of the inhabitants of Porto Rico live on 5 cents a day or less, estimated in American money; and in this class are to be found the people who perform the daily toil of the island. Indeed there are many who live from one week's end to another on so simple an article as sugar cane, and this cane is sold in the markets for that very purpose. Cocoanuts can be bought for 1 cent apiece, which are very nutritious and palatable, but hardly desirable to use largely as a ration for workingmen. I investigated the meals of workingmen of all classes many times, and am confident that their food is insufficient to produce a great amount of labor energy. It consists of a limited amount of bread, some tubers, and a few beans in a sort of a bean soup. This is the ration of field or factory workmen.

I investigated the wage scale of the sugar, tobacco, and coffee industries, and these are the chief ones of the island. These industries are much alike in their labor requirements. A great many boys from 10 to 15 years of age are employed. They get from 15 to 30 cents a day, Spanish money, or from 9 to 18 cents, American money. The unskilled adult laborer receives from 35 to 63 cents, or an average over the island of 50 cents a day, Spanish money. This equals 30 cents, American money. Bosses of gangs in the factory or in the fields get $1, Spanish money. Bricklayers, carpenters, plumbers, and other skilled workmen get the same. Of course in the factories there are required a few skilled men, such as "boilers," who get $50 per month (gold).

The money used on the island is of the following denominations: The peso or dollar, containing 100 centavos or cents, and fractional pieces with values as follows: 40 centavos, 30 centavos, 20 centavos, 10 centavos, 5 centavos, and 1 centavo. It is issued in gold, silver, and paper; but the silver and paper money is only worth 60 per cent of ours. There is considerable talk in Porto Rico about having the money placed on a gold basis so as to do away with the confusion of making exchange. The laboring people are very much in favor of this, while most employers are not. It is claimed that the laboring classes could never be made to comprehend and appreciate the fact that the basis of money dominates its value, but would continue to demand the same amount as heretofore, and, if they did not receive it, would refuse to work. Employers claim that to concede such a demand would be to increase wages 66⅔ per cent in one jump. I am inclined to believe this would be the result.

The rainfall and moisture conditions of Porto Rico are certainly very interesting. The variations are almost as great as they are in the United States. For instance, certain sections of the island have from 80 to 90 inches of annual rainfall. Other sections have not had any rainfall for three years. Between these extremes they have all the different degrees of moisture supply that we have in this country. The rainfall occurs principally in the northern and western sides of the island; the arid region is in the southeastern section; but through this dry region flow from the mountains streams that constantly supply the water from which part of the level tracts can be irrigated. In fact, irrigation is carried on to a considerable extent in the region of Guayama and the southern and eastern sections of the district bearing that name. Sugar cane is raised under irrigation, as well as tobacco and other products, but the opportunities for the investment of capital might be very much increased by the development of irrigation in this area.

The mouth of the principal river is about 20 miles east of San Juan. It is called Rio Grande de Loiza. It drains a region that is subject to heavy rainfall. It rises at certain seasons of the year and overflows the valley and coast belt which it drains for miles on each side. It brings with it large supplies of silt washed from the mountains, which spread over the soil and renew its fertility, acting in this respect something like the wonderful Nile. Sugar cane requires a great deal of moisture, and it seems to do best where the ground has been soaked most thoroughly, especially when the water is warm in the soil. The region drained by this river may be called the principal sugar section. It comprises the districts of Carolina and Canovanas. Twelve per cent of the sugar made on the island is made here. Another principal river flows south, called the Rio Guamani. It flows through the country in which irrigation is practiced.

The principal sugar districts are in the coast belt and valleys of the north side and west end of the island. Here the sugar cane does best, although it is grown pretty generally over the island. It might be concluded that on account of the mountain ranges the tillable area of Porto Rico is limited to the coast belt and the valleys, but it may be stated that the mountains are fertile to the very tops. On the sides of the mountains are to be found the coffee plantations. The great bulk of the coffee of the island is grown here. It becomes necessary to shade the coffee for protection from the sun on the sides and tops of the mountains, and other trees are planted for this purpose. This gives a coffee plantation viewed from a distance the appearance of a native thicket.

PRODUCTIONS OF THE ISLAND.

The following table shows the exports of sugar, coffee, and tobacco from the island of Porto Rico for the years 1896 and 1897. These comprise all the exports of the island except a few hides and cattle:

Principal exports of Porto Rico for the years 1896 and 1897, with their values in Spanish and United States money.

Product.	Quantity.	Value.	
		Spanish money.	United States money.
1896.			
Coffee ... pounds	61,223,046	$13,864,340	$8,318,604
Tobacco ... do	2,315,946	442,912	265,747
Sugar ... tons	58,000	3,734,862	2,240,724
1897.			
Coffee ... pounds	34,061,500	12,222,000	7,333,200
Tobacco ... do	6,340,314	1,194,318	716,590
Sugar ... tons	60,000	4,008,000	2,404,800

THE SUGAR INDUSTRY.

It will be noticed that the exports of sugar for these two years were as follows: For 1896, 58,000 tons, valued at $2,240,734 in United States money; for 1897, 60,000 tons, valued at $2,448,800. It is estimated by those most familiar with the resources of Porto Rico, and on this point the agreement is general, that the exportation of sugar could be increased 100 per cent, that is to say, doubled. This would result from the introduction of modern methods and modern machinery, along with drainage and other means of extending the cultivation of sugar cane to lands not now devoted to that purpose.

The sugar now exported from Porto Rico is about equal to 3 per cent of our importations, and if the industry in this island were increased to its fullest extent, then Porto Rico would be able to furnish 6 per cent of our importations.

SUGAR FACTORIES.

The methods of manufacturing sugar now in use in Porto Rico are very primitive, as a rule. There are a few that might be classed as up-to-date factories, but not many. There are only six factories on the island, for instance, that have a double-crusher system of getting out the sap, and the number of factories that have the triple-vacuum effect is limited. The methods in vogue range from the modern down to those which are obsolete, in which oxen driven to a sweep are used in pressing the juice out of the cane by means of iron and wooden rollers, and a large per cent of the factories have the open-pan evaporation.

I was able to find, in all the factories I examined, only one that supported a chemical laboratory and kept any record of data regarding the quality of the cane or the effectiveness of the processes employed. Except in this case, the factory people appeared to have no idea as to the amount of the sugar they were getting out of the cane, or the amount of sugar that remained in the molasses. Under such conditions, there was nothing to stimulate improvement of the process, or to test the improvement if they should attempt to make any.

As I stated, I found in one factory of English ownership that definite data were kept, and by following these and the judgment of those best posted I am able to state with a degree of certainty that the best work on the island secures a product equal to about 10 per cent of the original weight of the cane. Such results are confined to a few factories. A larger number are securing perhaps 8 to 9 per cent, and a still larger number less than this. The exact results no one will ever know, because those interested themselves do not know.

The better factories secure cane to work up in two ways. The first is illustrated in the method employed at the factory known as Central

De Canovanas, belonging to an English syndicate. This factory is managed by Mr. W S. Marr. In order to secure sufficient land to produce cane for the factory, the syndicate has purchased 2,000 acres and leased 2,000 acres more for a period of twelve years. This land is rented out to planters at a very reasonable figure. From the planters the factory buys its cane The cane is paid for as follows: The factory gives the planter an amount of sugar equal to 5 per cent of the crude weight of the cane, and then allows him for this sugar the market price according to the quotations. Of course the value of the cane fluctuates more or less. The other method of securing cane is illustrated in the case of the factory at Carolina, owned principally by Mr. George I. Finlay, who is British vice-consul at San Juan. The factory owns the necessary land and engages directly in the production of cane. Naturally the agricultural as well as the manufacturing side of the business receives close attention. Further along is given a detailed statement of the actual cost to these two establishments of producing sugar and putting it on our market in New York.

TIME FOR PLANTING CANE.

There are two periods for planting cane in Porto Rico—spring and fall. The spring planting runs from February to May, and the fall planting from August to December. The spring planting can be cut in from twelve to fifteen months, but is usually allowed to stand fifteen months, and the fall planting stands fifteen months as a rule. I found that the number of crops cut from one planting ranges from one to eleven, that being the highest reported. In a majority of cases the number of cuttings from one planting is three or four.

CULTIVATION.

The system of preparing the ground and cultivating sugar cane in Porto Rico is as follows: The land is first plowed about 9 inches deep. It is then cross plowed twice; sometimes it is harrowed. Then between every second row and running with the rows a ditch is dug with a spade about 1 foot deep and 1 foot wide, the dirt being thrown up on the center of the ridge left between this and the next ditch, which ridge is wide enough for two rows of cane. Main drains are run around the side of the field and cross drains occur about every 2 or 3 rods. Of course these cross and main drains are considerably larger than the regular cultivation drains. The rows are about 7 hands apart, and the hills in the rows are about 6 hands apart.

The cultivation consists simply in hoeing about three times, which is sufficient to keep the weeds down until the cane is large enough to be out of danger from them. In about nine months the main part of the leaves is stripped off from the cane, and about a month before harvesting this is done again with a view to allowing the sun and air to do their part in the formation of sugar. The operation is called "trashing."

COST OF CULTIVATION.

Mr. Finlay estimates the cost of growing a crop of cane as follows: First crop, as described above, $60 Spanish money per acre; the second cutting (the first rattoon) $20 Spanish; the second and third rattoons each $20 Spanish. This would be four crops from one planting, and the average cost would be $30 Spanish or $18 United States money. The cost of a rattoon is simply that of hoeing, weeding, keeping the ditches open, doing the trashing, etc. From Mr. Finlay's books I found the actual cost as charged to be for producing 748½ acres of cane $20,769.93, an average per acre of $27.75 Spanish or $16.65 United States money. Embraced in this average is the expense of first, second, third, and fourth crops. The books further showed that it cost about $30 Spanish to harvest and deliver to the factory 1,000 quintals of cane. This would be at the rate of $6 Spanish per ton.

OBSTACLES.

Growing sugar cane in Porto Rico has its difficulties, the same as crops in all other parts of the world. Among these difficulties may be mentioned too little rain, too much rain, rain at the wrong time, insects, blights, and worms. There was a time when the common house rat was a great and serious pest to the sugar-cane fields. In order to do away with this pest, the mongoose (a little animal belonging to the civet family) was imported. It is called in Spanish "ardilla." A peculiar and complete change has been brought about in the habits of the rat. The few left build their nests in the tall cocoanut trees, where they are free from the attacks of the mongoose and where they propagate. They live on cocoanuts and venture out very cautiously. The mongoose, on the other hand, having accomplished his mission as a friend of the planter, becomes a pest himself. Not finding any more rats to kill, he turns his attention to chickens and other fowls, and becomes especially fond of eggs, thus making poultry and egg production very expensive and hazardous.

The borer worm does a great deal of damage to cane by working on the inside of the stalk, boring the heart out of the same. There are a number of blights that are not well understood. Occasionally a cane-field that gives every indication of perfect health suddenly languishes and becomes a partial or complete failure, apparently without any good reason. Scientists will doubtless make these things clear when the island becomes more Americanized.

YIELD OF SUGAR CANE.

According to the best information gleaned from the best cane growers, the first crop on the best land yields from 35 to 45 tons per acre on an average. On the best cane ground the first crop with the three rattoons would produce an average of from 15 to 20 tons.

Mr. Marr, of Canovanas, says that the first crop on good ground should be 40 tons per acre, with rattoons ranging from 20 to 25 tons, but he says there is much land that is tired out, from which may be expected such yields as the following: First crop from 20 to 22 tons; first rattoon from 15 to 16 tons; second rattoon from 10 to 12 tons. The average of the rattoons is about 16 tons per cutting. Mr. Finlay makes the following estimate: Good ground, first crop 40 to 45, first rattoon 20 to 25, second rattoon 20 to 25 tons per acre; second class ground, first crop 40 tons, and rattoons, considered inferior, ranging from 12 to 15 tons. The same gentleman also says that the best varieties are Salangore and Olaheiti.

Mr. Marr states that they extracted in sugar a small fraction above 10 per cent of the weight of the cane worked. Mr. Finlay says their sugar last year equaled 9.04 per cent of the weight of the cane; and for the two years preceding last year 8.7 and 9.25 per cent, respectively.

HON. GEORGE I. FINLAY'S ESTIMATE OF THE COST OF MAKING SUGAR.

Mr. Finlay says that it will cost him 15 cents per hundredweight, United States money, to transport his sugar from the mill and place it aboard ship. The mill is 3 miles from the railroad, and the station is about 16 miles from the seaport. It costs him 15 cents per hundredweight to ship his sugar from the seaport to New York. If shipped in bags it costs 2 cents more than if shipped in hogsheads. It costs him $1.74, United States money, to produce a hundredweight of sugar, including cost of cane. He figures the expense for delivering the cane to the mill at 2.72 cents per hundredweight of sugar, in gold. This would make a hundredweight of sugar cost him at New York $2.0672, exclusive of import duty.

In the case of this factory, field hands are boarded. The books show that it costs 12 cents, Spanish, per day for each man. The object in furnishing the meals is to give the hands more nutritious food than they would otherwise get, with a view to getting better labor. This cost of living is considered higher than the average throughout the island.

The following statement and estimates are based upon data from the books of Mr. George I. Finlay, British vice-consul at San Juan, also the principal owner of a large sugar estate and mill situated near Carolina, Porto Rico.

All cane is raised by this concern on their own and rented land. The estimate for the cost of the manufacture of a ton of sugar is a little higher than that of the concern at Canovanas managed by Mr. Marr, because the items of repairs and taxes include the cost of repairs and the taxes on the plantation and tramways which run out to the fields, as well as on the plant proper. But this difference will not appear in the estimate of the total cost of making a ton of sugar. The statement of cost of manufacture is as follows:

The cost in Spanish money of making 100 pounds of sugar.

Labor in works	$0.1772
Fuel	.0870
Bags	.1006
Repairs	.1600
Repairing railroad	.0366
Repairing works, carts, etc	.0922
Care of 700 head of cattle	.0818
Taxes on mill and farm	.1100
General miscellaneous expenses, salaries, etc., not including interest on investment	.4415
Expenses on manufactured sugar, such as weighing, delivering to port, etc	.1583
Total	1.4402

The total cost of making 1 ton of sugar at the rate of $1.44 per hundredweight is $31.68, Spanish. This in United States money would be $19. The cost of producing a crop of cane is estimated to be $1.45, Spanish, per hundredweight of sugar, which would be $31.90, Spanish, per ton of sugar, or $19.14 in United States money.

The cost of harvesting is put at $30 per thousand quintals (100,000 pounds or 50 tons) of cane, or 60 cents per ton. Estimating the amount of cane necessary to make a ton of sugar as 10 tons, the item of harvesting and delivering is 60 cents multiplied by 10, or $6 (Spanish), which equals $3.60 United States money.

Bringing together the cost of these various operations in their natural order, we have the following:

Cost of producing cane for 1 ton of sugar	$31.90
Cost of harvesting cane for 1 ton of sugar	6.00
Factory cost of producing 1 ton of sugar	31.68
Total cost of production, per ton, in Spanish money	69.58
Total cost of same, reduced to United States money	$41.75

As the ton here used contains 2,204 pounds, the cost per hundredweight is $3.16, Spanish, or $1.89 United States money.

By adding $3.30 for cost of transportation to New York, which is the same as that given by Mr. Marr, we have $45.05, United States money, as the cost of a ton of Porto Rican sugar laid down in New York (exclusive of import duty), which is $2.044 per hundredweight, or 2.044 cents per pound.

Adding to this cost per pound the import duty of 1.68 cents, we have 3.724 cents per pound. That is to say, the sugar producer of Porto Rico can place his product in New York for a slight fraction over 2 cents per pound, or a little less than 3¾ cents including the import duty. In the case of this factory, nothing was allowed for sinking fund or interest on the money invested in plant, or insurance on sugar in transit, in estimating the cost of production. This with the profits is represented by the margin between cost and actual selling price, as shown in the table on page 125.

As near as I could ascertain values of investments, I estimated this margin roughly, and in the case of the Canovanas factory it was 6.5 per cent; in that of the Carolina factory it was 4.5 per cent on the investment.

The following shows the daily wages paid in the Carolina factory:

Boys, from 15 to 30 cents, Spanish, or 9 to 18 cents United States money. Men, from 35 to 75 cents, Spanish, or 21 to 45 cents United States money. Bosses, about $1, Spanish, or 60 cents United States money. The average wages per day for men is about 50 cents, Spanish, or 30 cents United States money.

Mr. Marr's statement follows. The estimates were taken from the books of the Canovanas factory:

MR. W. S. MARR'S ESTIMATE OF THE COST OF MAKING SUGAR.

In making up this table I have used the ton of 2,204 pounds, and reduced all values to United States money.

The actual factory cost of making a ton of sugar, as shown by the books for a series of years, is $16.

Our cane costs us on estimation as follows: We give the planter in sugar 5 per cent of the crude weight of the cane he brings us, which would be 110 pounds of sugar per ton. We give him our check for this amount at the market price according to quotations, less 20 cents in gold on each ton of cane. Our cane costs us at the present prevailing prices $1.92 per ton, and since our average extraction of sugar is 10 per cent of the cane worked, the cane required to make a ton of sugar is 10 tons, and 10 multiplied by $1.92 equals $19.20.

It costs us to cargo our sugar as follows: Factory to Carolina, 4 miles, 12 cents per ton; from Carolina to San Juan, 16 miles, 53 cents per ton, cargo on board 31 cents per ton, making the total cost per ton 96 cents.

It costs us to ship sugar to New York as follows: By sail (in sacks) 12.5 cents per hundredweight; by steam (in sacks) 15 cents; by sail (in hogsheads) 15.5 cents per hundredweight; by steam (in hogsheads) 17.5 cents per hundredweight. Then supposing the product to be shipped by steam in sacks, we have cost of transportation to New York per ton $8.30. Now, bringing together in their natural order all these items of cost, we have the following:

Cost of cane	$19.20
Cost of manufacture	16.00
Cost of placing on shipboard	.96
Cost of transportation to New York	8.30
Total cost of a ton of Porto Rican sugar laid down in New York	39.46

The foregoing includes all the items of cost except that of insurance on the cargo in transit. The import duty is not included.

According to the preceding statement, the cost of producing this sugar and transporting the same to our markets is a fraction less than 2 cents per pound, or, to be exact, 1.82; the fraction less doubtless much more than covers the insurance.

This sugar usually arrives as refining sugar polarizing 95 to 96 degrees, and must pay duty, which on sugars of this class is $1.68

per hundredweight, or 1.68 cents per pound, so that the actual cost of this sugar in our markets, including the import duty (disregarding the item of insurance mentioned above), is 3.5 cents per pound.

The difference of over $5 per ton between the cost of production at the Canovanas factory and at the Carolina factory results largely from the difference in the amount of sugar secured from the cane, a difference in favor of the former factory equal to about 1 per cent of the weight of the cane, or 220 pounds per 10 tons of cane (the amount required to produce a ton of sugar at the Canovanas factory). This difference in product at $35.20 per ton, its actual cost at the Canovanas factory, is worth $3.52.

I wish to state that while it was my privilege to examine into the workings of a great many sugar factories, in statements touching the sugar industry of Porto Rico I have referred more particularly to Mr. W. S. Marr and Hon. George I. Finlay for two reasons: First, these managers have complete data covering all the workings of their establishments, which are equipped in such a way as to show up the resources of the sugar industry of the island when working under its best condition; second, through the courtesy of these gentlemen, I was allowed to gather from their books and experience every item of information desired, so that the statements given concerning them and their works are based on the actual facts.

I wish here to express my obligation to these two gentlemen for the courtesy extended in aiding in every way possible to facilitate my work, not only with reference to the sugar industry, but with reference to the various resources of the island, with which they are well acquainted.

BY-PRODUCTS.

There are no by-products to speak of incident to the manufacture of sugar from cane. Nearly all the factories of the island work up their waste molasses into rum. It takes about 2½ gallons of molasses to make a gallon of rum, according to the statement of Mr. Marr. Factories are able to sell this rum for about 38 cents a gallon, according to the statement of Mr. Finlay. If a factory does not make rum, it sells its molasses to some factory that does for about 5 cents a gallon. This rum has a local market as a native drink; it is also used in the manufacture of bay rum of certain quality, and in compounding other drinks, like poor gin and whisky. The "megass," or refuse of the cane stalks after the juice has been squeezed out, might be called a by-product, because it is used for fuel. The fuel used in these factories is composed almost entirely of this megass, very little wood or coal being used; in a great many factories the megass is entirely sufficient. In some cases it has to be dried in the sun, which makes it more expensive. In other cases factories have special appliances for drying it, and are enabled to use it soon after it leaves the crusher. When it is considered that these factories would have to be at some expense to dispose of this waste if they did not burn it in their furnaces, it can be seen what an admirable arrangement this is. I asked several factory men if they would not prefer coal, and they claimed that they would prefer the megass as fuel for the factory. I asked Mr. Marr how cheap coal would have to be before he would use it instead of megass, and he said that he would not use it at all if he had the megass. I asked Mr. Finlay the same question, and he said that the coal would have to be cheap enough to make it desirable to haul the megass back on the land for manure rather than use it for fuel. These statements show that the fuel problem is not difficult in these tropical islands. I have noticed in some of the write-ups of the sugar industry in the Hawaiian Islands, the Philippines, and Cuba that the fuel problem will always stand in the way. It seems to me, on the contrary, that they are greatly favored in this respect. The amount of megass produced is about 30 per cent in weight of the cane worked.

As stated before, the factory managed by Mr. Marr was the only one that had definite chemical analytical data regarding its work. He says that the sugar in the cane equals about 15 per cent of the original weight of the cane, with a purity coefficient of about 86. From the 15 per cent 2½ per cent must be deducted as the part remaining in the megass and an equal amount as the part remaining in the molasses, leaving 10 per cent, or a slight fraction over, as the sugar actually secured, or an amount equal to one-tenth of the original weight of the cane. The molasses contains from 38 to 40 per cent of cane sugar and from 26 to 30 per cent of glucose.

MARKET PRICE OF SUGAR.

The following statement represents the average market price of sugar at New York in United States money (shipper paying freight) for a series of months, as taken from the books of a commission house in Porto Rico:

(1) Centrifugal (polarization, 95 to 96 degrees):	
Selling price—	
Per pound	$0.025625
Per hundredweight	2.563
Per ton	56.39
Tariff per hundredweight	1.68
Selling price, duty paid—	
Per hundredweight	4.243
Per ton	93.346
(2) Muscovado (polarization, 89 degrees):	
Selling price—	
Per pound	.02375
Per hundredweight	2.375
Per ton	52.25
Tariff per hundredweight	1.44
Selling price, duty paid—	
Per hundredweight	3.811
Per ton	83.875

(3) Molasses sugar (polarization, 89 degrees):

Selling price—	
Per pound	.02125
Per hundredweight	2.125
Per ton	46.75

NEEDS OF THE ISLAND.

Having given a brief account of the conditions, resources, and present status of the sugar industry in Porto Rico, I will offer some brief suggestions through which better conditions may prevail in the industries of the island, placing them on a more flourishing basis.

ROADS AND METHODS OF TRAVEL.

One of the most immediate demands of the island is good roads and some good system of keeping them in order after they are made. The island being mountainous and having a great many streams and a heavy rainfall in most sections, the roads, especially for carrying heavy loads, become almost impassable. The military roads are all right. What we need is better roads connecting with these. At the present time public roads are simply trails, which seem to exist by a sort of sufferance. You can travel but a little distance on any public road until you encounter a fence, a section of which must be removed before you can continue. Then these roads are crooked, irregular, narrow, and laid out apparently without any system. Deep gullies, cuts, ruts, and everything that tends to make a road bad are the rule. There seems to be no system of repairing at any time. Now, in a country where so much of their produce must be carted around, the heavier the loads the more economically moved, it would seem that the most desirable thing would be good roads. So I place it first and most important among the needs of this island.

After good roads, the next thing will be a quicker and better means of travel. Oxen are all right to a certain extent, and they will always have to be used. The fields will always be difficult of access, the ground wet and soft, and it takes the ox to feel his way along and take his time to bring the load after him. I think, also, that the ox could be used much more effectively if he could propel his load differently. But for the transferring of heavy loads on good roads, where speed is desired, it seems to me they will have to resort to the mule or draft horse. The horses they have there now are simply small ponies, which are used entirely for riding.

ROTATION OF CROPS.

At the present time Porto Rico has been growing cane on the same land year after year for a century or more. Another one of the great needs of the island is a system of rotation of crops. The land is productive, the climate seems right for producing a great many things that would be profitable, and it is certain that experimentation would show that many plants could be added to the very short list of those cultivated at present, so that rotation of crops would be entirely feasible. At the present time they are especially in need of forage plants.

MODERN METHODS AND MACHINERY.

Modern methods and machinery of all kinds are lacking and are, therefore, greatly needed. Skilled work performed there seems to be very slowly and very poorly done; in fact, this applies to every kind of labor performed. The agriculture of the island is certainly performed with a very limited schedule of implements.

WAGES.

Labor, to be good and effective, must be well-paid labor. About 30 cents a day (gold) is the average wages paid to the workingman. Upon this he must feed and clothe himself and family. We certainly can never make any progress with public schools or general education where people are compelled to subsist on such wages. We can not expect a very high degree of intelligence among the common people. These wages are certainly incompatible with the American theory, and in some way a material increase in wages should be brought about. This must be the basis of better conditions in everything else. The wages must improve before we can have a cheerful and comfortable home life or intelligent citizenship, which are desirable and necessary as the basis of future self-government.

FOOD RATIONS.

A better food ration is certainly one of the crying needs of the island. It is so intimately connected with the subject of wages that it seems hardly more than necessary to mention it here, because an opportunity must be given to anyone before he can improve his daily food rations. Both of these questions are so intimately related to the industries of the island that I feel like emphasizing them in the list of needs. As has already been stated, over half of the people of Porto Rico live on less than 5 cents a day, and there is a large number who live on less than 3 cents a day. The necessity of improvement in this respect is apparent to everyone.

EDUCATION.

Again, the industrial problems of Porto Rico can never be solved until there shall have been a revolution in respect to education. The educational system of the island amounts to very little. About 10 per cent of the children attend public schools. There are two or three colleges, and they bear considerable resemblance to the system of public schools.

There ought to be a more detailed system devised for labor and manual training. Agricultural colleges and experiment stations would do very effective work in the island. Attention should be given especially to that kind of education that has to do with the training of the mind and hand together. All of this must necessarily precede the industrial development of the island to that high degree to which its fertility, climate, and natural resources entitle it.

FRUIT CULTURE.

Porto Rico can produce any of the tropical or semitropical fruits, and has a large list of them already. They grow wild and apparently as free as the air to any who see fit to gather them.

In California, where oranges are an item of industrial and commercial interest, orange culture is an intricate work, and it requires a great deal of labor and expense to produce a crop. The crop of oranges that grows in Porto Rico receives no attention whatever. The trees are not really planted in orchards; they grow here and there, apparently by permission, in the hedges, on the sides of the hills, and on abandoned lands, absolutely without care or attention. Now, the question arises, What might not Porto Rico do, provided proper attention and care were given to culture and selection of varieties, with proximity to our shores and with water transportation? She might enter the field as a producer for our markets, or in fact for any other market. The same is true with reference to her cocoanuts, guavas, bananas, and many other fruits that might be mentioned.

Development of the fruit industry would improve conditions generally in the island. It would yield a healthful, strengthening, inexpensive element of food, which is very desirable in a well-balanced ration for laborers as well as for others.

MONEY.

Porto Rico needs a better money. What they have is very unstable, and its fluctuations in value create endless confusion. This is especially the case now that Americans and foreigners are engaging in business there. Certainly a good financial system is fundamental to a successful industrial system.

CENTRAL FACTORIES.

One of the greatest needs of the island in connection with the sugar industry is a system of central sugar factories. At present, if a man has a body of ground that happens to be good sugar-cane ground, in order that he may realize from the productiveness of it, he makes a sort of sugar plant, be it ever so small, inefficient, or obsolete in its methods and machinery. A system should be devised that will appeal to all these small producers in a business way. That it will be more profitable and better in every way to have one large central factory, with modern machinery and methods, where sugar can be produced more cheaply and of a higher grade, ought to be apparent to all concerned. This can be accomplished by cooperation, or by the system used by Mr. Marr of buying the cane and paying for it in sugar. The principal advantage of such a system lies in the economies which naturally result from manufacturing, handling, and selling the product in large quantities.

MARKETS.

It is a plain matter of fact that the island is reduced to the extremity of depending upon the United States for a market for her products. Formerly Spain afforded a market, but it is claimed by the Porto Ricans that it has been lost, and that their only outlet is in the direction of the States. This being the case, all favors shown the island by our people and Government in the way of lower duties and cheaper transportation of her products will add to the profits of the island's industries. It is only fair to state that at present the industries of Porto Rico are in a very depressed state.

EXPERIMENT STATIONS.

When we consider the present limited resources of the island, and at the same time its agricultural possibilities, the necessity for an experiment station suggests itself very forcibly as a practical method for quickly increasing these resources and at the same time introducing better agricultural methods. This is another important need of the island.